Surveying and Mapping

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April – June 1956

Quarterly Journal

AMERICAN CONGRESS ON SURVEYING AND MAPPING

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The Canadian wilderness, great treasure-house of new mineral resources, needs maps to speed its development. Treacherous muskeg . . . far below zero temperatures . . . remote areas . . . these and other problems make mapping difficult. The answer: Turn the job over to experienced AERO crews. These men are used to mapping in wilderness areas. They're equipped with the skills, the instruments and the know how to get complete, accurate map data for you efficiently, economically.

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SURVEYING AND MAPPING is the official journal of the Congress and is published quarterly during the months of March, June, September, and December. The Congress welcomes articles and interesting news items for publication in its journal. Manuscripts should be sent to the Chairman of the Publications Committee.

For further information, write to

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SURVEYING AND MAPPING is published quarterly by the AMERICAN CONGRESS ON SURVEYING AND MAPPING, Box 470, Benjamin Franklin Station, Washington 4, D. C. Yearly subscriptions to non-members: U. S. $5.00; foreign $6.00. Single copies $1.50 plus postage.

Entered as second-class matter at the Post Office at Washington, D. C., November 13, 1944, under the Act of March 3, 1879. Additional entry as second-class matter at the Post Office at Lancaster, Pa.

SURVEYING AND MAPPING

Editor-in-Chief
Howard S. Rappleye,

A QUARTERLY JOURNAL
DEVOTED TO THE ADVANCEMENT OF THE SCIENCES
OF SURVEYING AND MAPPING

Volume XVI, No. 2
April–June 1956

PUBLISHED BY THE
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The Surveyor's Notebook

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How Disney's Magic Kingdom Grew in an Orange Grove

Disneyland: Before...

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"When we first started work on Disneyland—just about one year before it opened—it was a 160-acre orange grove," recalls Donald J. Hallgren, Walt Disney's Field Engineer on the job. "McNeil Construction Company, Los Angeles, furnished all the necessary equipment, men and materials; Disneyland, Inc. furnished plans, specifications and the engineering personnel.

"This is where I came in as coordinator between plans and building phases of the job. My job was to coordinate the survey, staking, etc., necessary to keep the prime contractor's crews of carpenters, electricians and earthmovers busy.

"Imagine an orange grove with a tree every 25 feet, and you'll see our problem. Out of this grove was constructed a half-mile long river, six feet deep and averaging 200 feet wide along its winding course, with waterfalls, sandbars, docks and drydock for a real paddle boat. (This boat, like everything else in the park, was built ⅝ths scale.) Another river was built one-quarter of a mile long, depicting any jungle in the world, complete with mechanical moving animals. It would take a small volume to detail the unusual problems and angles we encountered.

"Without the excellent work turned in by our survey parties, this job could never have been completed on time. During grading operations for our 100-acre parking lot, for instance, earthmovers needed grid and grade stakes on every 50-foot square. I would have one party doing nothing else but running lines and driving lath and flats, and two more crews following them, reading and marking the cuts and fills. As fast as my men drove the stakes, the equipment would cut and fill around them. I sincerely believe that, at one time or another, every square foot of that 160 acres has had a two-inch-by-two-inch hub driven in it for one reason or another.

"Imagine the strain on my crews—to be just starting a layout for a building, have all control run and to be getting ready to run line, and then have me drive up and move them over to some still higher-priority job. With all this confusion, there was one thing we could *always* count on. That was the precision and rugged nature of our Gurley instruments, which never let us down in a jam.

"Now, watching all the children at Disneyland having such a great time in their magic kingdom, it is difficult to remember the hectic side of those construction days. Let's just say: 'Never was so much done, in such a short time, by so many!'"

"Surveyor's Notebook" Tips

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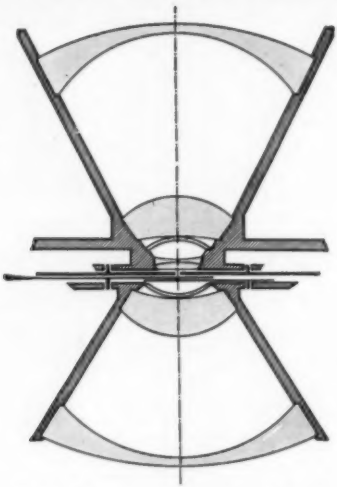
WIDE-ANGLE AERIAL SURVEY CAMERAS



RMK 11.5/18 for a negative size of 18 cm x 18 cm (7"x7"), focal length 115 mm (4 1/2")

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Both types of cameras are equipped with the new wide-angle Pleogon lens f/5.6 – a high-performance lens with superb image resolution and 100% better illumination in the corners than with the Topogon lens. With a maximum distortion of only ± 4 microns the Pleogon is superior to all other lenses with an angular field of 100 g .

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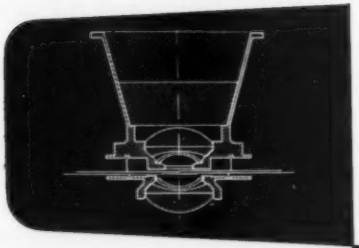

After production of photogrammetric instruments had been resumed in West-German Zeiss Works, the high-performance

ZEISS TOPAR LENS

was developed. Excellent image resolution, superb illumination up to the very corners of the negative, color-corrected, maximum distortion of ±4 microns – these are the characteristics of pictures taken with our 8 1/4" Aerial Survey Cameras RMK 21/18 and 2 x RMK 21/18 (Convergent Camera).

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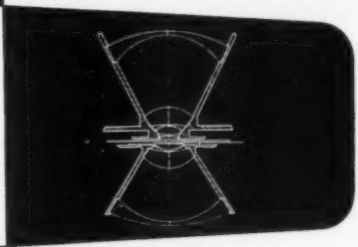

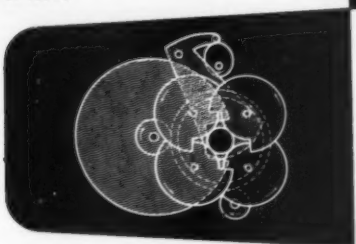

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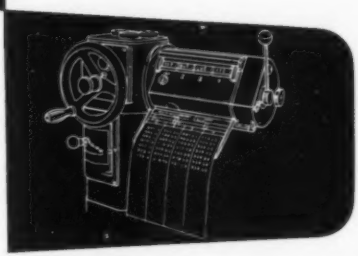

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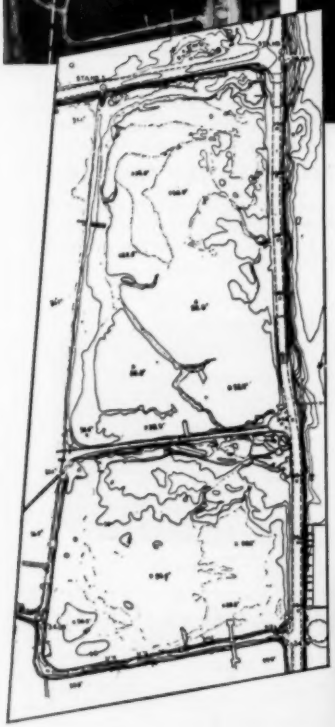

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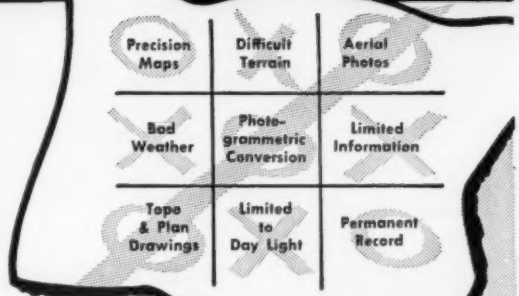

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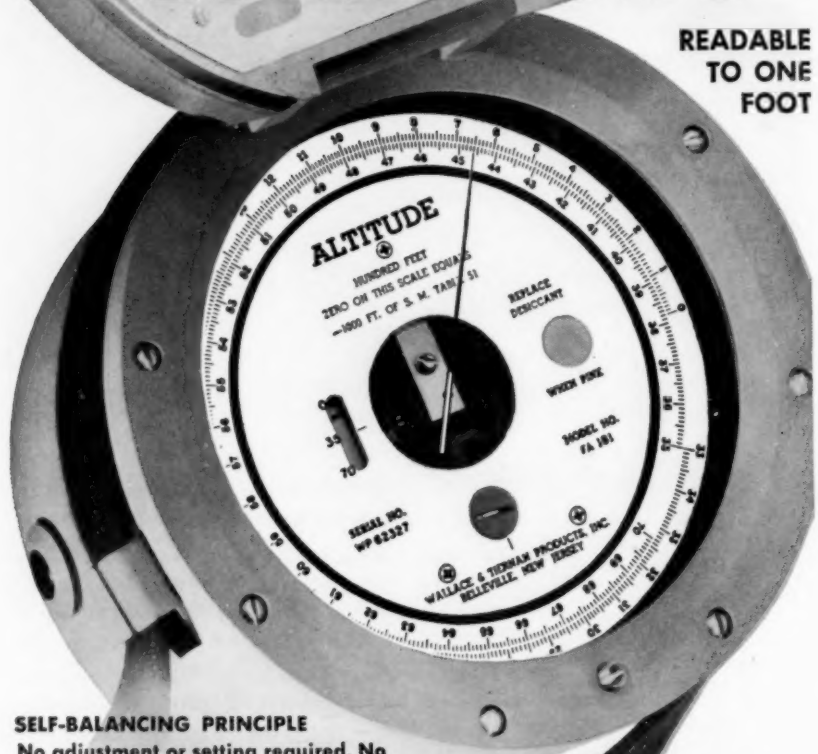

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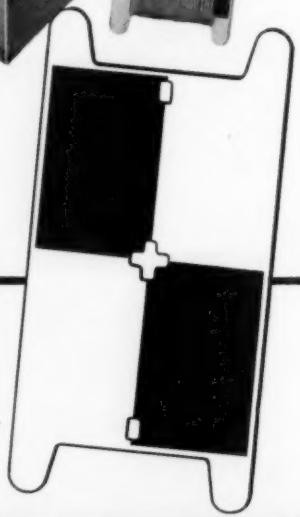

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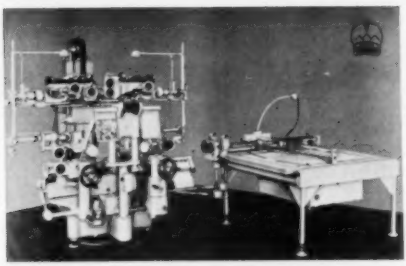

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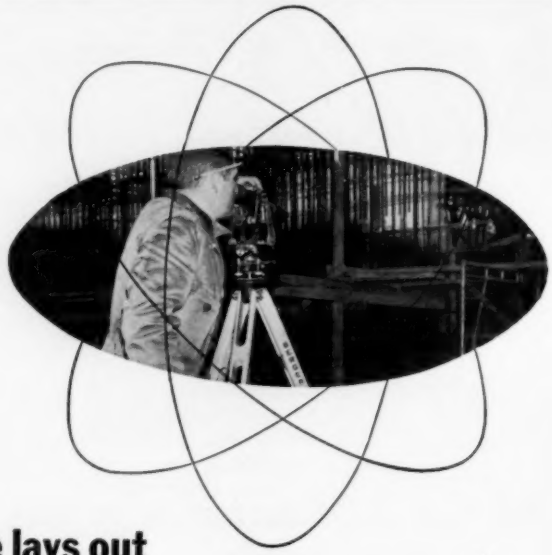

Gilbane lays out new atomic vistas for Tracerlab with BERGER TRANSITS

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The Sixteenth Annual Meeting

THIS MARKED the second year for holding Consecutive Meetings and a Co-Exhibit of the American Society of Photogrammetry and the American Congress on Surveying and Mapping. The entire week of March 18 was given over to this cooperative program with each organization providing a full schedule of meetings which were independent with respect to the organizations but unified in purpose. The ACSM opened the week with its Sixteenth Annual Meeting and the ASP closed the week with its Twenty-second Annual Meeting.

The Registration Desk for the Meetings opened on Sunday evening, March 18. A spring snowstorm, which started on St. Patrick's Day in the northeastern part of the country, seemed to arrive in the Washington area at the same time the members of these organizations were arriving for early registration. Even on Monday traffic conditions had not returned to normal and there was some slight delay in opening the simultaneous sessions of the ACSM Divisions.

A new record was set for attendance with more than seventeen hundred registrants. There were visitors from many foreign countries who appreciate the opportunity of attending two national meetings for the cost of a single trip.

The keynote address by Dr. John J. Theobald, Deputy Mayor of the City of New York and President of Queens College, was given at a General Assembly on Wednesday, March 21. His address is published in this issue of SURVEYING AND MAPPING. The various social functions were also held jointly. The technical division meetings and plenary sessions were separate, yet open to all who had registered regardless of organization affiliation.

Plenary Sessions

Five of the technical divisions held simultaneous sessions on Monday morning, March 19. These were very well attended and details of the meetings are given under the division reports.

Lester C. Higbee, President of the American Congress on Surveying and Mapping, opened the plenary sessions of the Congress at 2 p.m., Monday, March 19, with a near-capacity attendance. He greeted the members, welcomed the guests, and reviewed his activities for the past year, with particular mention of the visits to local sections and to the Pan American Institute of Geography and History in Mexico City. Mr. Higbee then pointed out several possible opportunities for Congress action in the future, especially in engineer-surveyor licensing, education, and professional ethics. He told of the growth of the Congress, not only in numbers, but also in enthusiasm, in interest, and in service.

Rear Admiral H. Arnold Karo, Director, Coast and Geodetic Survey, gave the principal address of this first plenary session on the subject "World Mapping." Admiral Karo discussed quite thoroughly the world map coverage, pointing out the responsibilities of the various governments in maintaining and increasing this coverage. He gave a complete and comprehensive review of the role of geodesy in mapping operations with an excellent discussion of astronomic and gravimetric observations and their use in geodetic surveying. Great progress is now being made with the various relatively new electronic aids, particularly in the much-needed intercontinental triangulation systems. Admiral Karo was interrupted during the delivery of his paper and had to leave the hotel to appear before a Congressional Appropriations Committee. Captain Charles Pierce, Chief of the Geodesy Division of the Coast and Geodetic Survey, read the remainder of the paper.

INSTRUMENTS DIVISION

Chairman Talbert Abrams of the Instruments Division presided over the remainder of the Monday afternoon plenary session, as well as the Instruments Division business meeting that followed.

The first paper was presented by Rolland L. Hardy, Consulting Engineer, Springfield, Va., and was entitled "Pendulous Cantilever Principles Applied to Self-Leveling Instrument Design." Mr. Hardy described a system for self-leveling instruments by means of a flexural member with a pivot, exploiting the resistance of materials to bending. Mr. Hardy stated the essence of his approach to the problem as "flexural compensation, resulting from the fact that the bending component of a vertical load on the free end of a vertical cantilever is equal to or varies proportionately with the torque produced by small angles of rotation at the fixed end." Mr. Hardy outlined structural equations pertinent to the solution of the problem. He then described his designs for experimental models, including a pendulum-actuated vertical circle attachment for telescopic alidades, and a pendulum-actuated automatic leveling attachment for conventional-type levels. Field tests with the automatic leveling attachment proved the practicality of previously developed theory, the speaker stated.

The second paper, by Raymond L. Sargent, President, R. L. Sargent Company, Houston, Texas, was on the subject "Repairs and Maintenance of Surveying Instruments." Mr. Sargent emphasized throughout this paper that the instrument user should and must make minor repairs and adjustments, but that major repairs, especially on optical-reading instruments, should be made only by skilled technicians either in the factory or in repair shops having factory-trained personnel. Cleaning of essential parts, Mr. Sargent said, must be done whenever they become dirty, rather than by a fixed time schedule. He gave many pointers on how best to do the cleaning and lubricating necessary for efficient performance. In closing he also stated that tripods, too often an overlooked part of instrument maintenance, require the same attention.

The third and last paper sponsored by the Instruments Division was "The Self-Indexing Alidade" by Ward H. Bolter, Keuffel and Esser Co., Hoboken, N. J. Mr. Bolter stated that their new alidade, now in production, is an entirely new design, as they decided to throw away all previously conceived ideas of how an alidade should be made and what features were necessary. He exhibited two, the standard and the expedition models, and pointed out the differences in the new and the older designs and features. He also showed a diagram of the self-leveling mechanism consisting of an air-damped pendulum. The new alidade is optical reading, and is streamlined in appearance, with all precision parts completely enclosed. The only field adjustment provided is for setting the index mark to give the correct reading for any given slope.

TOPOGRAPHY DIVISION

Chairman G. S. Druhot of the Topography Division presided at a plenary session on "The National Mapping Program—a Review of Progress," held on Tuesday morning. The principal paper was presented by Gerald FitzGerald, Chief Topographic Engineer of the U.S. Geological Survey. Mr. FitzGerald traced the history of topographic mapping in the United States from 1777 to the present, particularly the origin, growth, and present structure of the Geological Survey's Topographic Division. The general plan for the Division, formulated some 10 years ago, provides for: (1) use of the most modern techniques in map preparation; (2) adoption of engineering standards of accuracy; (3) expanded activity in research and development; and (4) planning and controlling production operations to obtain the highest efficiency. Mr. FitzGerald cited a number of technical developments, including new photogrammetric instruments and procedures, and cartographic techniques, that have contributed to the implementation of the general plan. Production of topographic maps has increased materially because of a stable and well trained operational force and because research and development activities are paying off. The speaker described the present mapping program of the Geological Survey and its relationship to the programs of other Federal mapping agencies. In discussing the future topographic mapping program, Mr. Fitz-

Gerald estimated that adequate coverage of the United States can be completed in 17 years at a cost of about $220,000,000. He explained that this estimate did not include map revision.

Prepared discussions supplementing Mr. FitzGerald's paper were presented by Colonel Julian D. Abell, Commanding Officer, Army Map Service, and Rear Admiral H. Arnold Karo, Director of the Coast and Geodetic Survey. Colonel Abell reviewed the development of our nation's military mapping program and described activities of the Army Map Service. Although the major part of Army Map Service's productive capacity is devoted to mapping of foreign areas, the agency is preparing an important category of domestic maps—the 1:250,000 scale series covering the entire country. AMS also cooperates with the Geological Survey and the Coast and Geodetic Survey in the conversion of civil editions of certain map series to military editions. The agency maintains an active interest in the improvement of equipment, procedures and techniques for mapping, and is now developing new approaches to key problems in geodesy and photogrammetry.

In Admiral Karo's absence, his discussion was read by Captain Charles Pierce. The Coast and Geodetic Survey supports the national topographic mapping program with the establishment of the primary geodetic control networks of the United States. Admiral Karo outlined the control activities of the Bureau since its beginning in 1807, emphasizing the great strides made in geodetic work in the past several decades. Major efforts have been devoted to triangulation in Alaska, the provision of survey control for the Federal mapping and water resources programs, and the development of the plane coordinate system for each state. The Coast and Geodetic Survey is active in the application of new electronic techniques to geodetic problems, including the use of the geodimeter for precise base-line measurement, and electronic computing equipment to accelerate geodetic adjustments. Admiral Karo cited the excellent cooperation of the Geological Survey, the Coast and Geodetic Survey, and the Army Map Service in executing the national topographic mapping program.

CONTROL SURVEYS DIVISION

The second part of the Tuesday morning plenary session was under the direction of the Control Surveys Division with its Chairman, E. D. Morse of Houston, Texas, presiding.

The first speaker was J. E. R. Ross, Dominion Geodesist of Canada, who spoke of the accomplishments on control surveys in Canada, with particular reference to the shoran measurements which have been made for the extension of control into the northern limits of Canada. Mr. Ross also reviewed recent accomplishments in the extension of triangulation and leveling in the southern portion of Canada. When one considers the size of the area to be surveyed, the short summer season that is available, and the logistical problems, outstanding progress has been made in establishing control in these areas where the data are needed for many different activities related to the defense of the North American continent.

The second speaker was Dr. John G. McEntyre, Associate Professor of Civil Engineering, Kansas State College, Manhattan, Kansas, who spoke on a suggested code of laws regulating land surveying and land registration. Prof. McEntyre pointed out many of the inefficient operations which take place in the simple procedure of selling land under our present existing systems. He proposed a system which would simplify these operations and would provide greater efficiency not only in the legal transfer but also in the keeping of fundamental records. The State coordinate system would be used for referencing all properties.

The third and last paper of this plenary session was given by William R. Cook, Surveys Engineer with the J. E. Greiner Company of Baltimore, Maryland. He spoke on "Control Surveys and Photogrammetric Maps for Superhighways and Toll Roads." He used as an example the experience of the Greiner Company in preparing maps

and furnishing survey data along the Ohio Turnpike. The schedule of operations for this project required that maps for a 240-mile stretch of the highway be completed within ten weeks. These maps were of a strip 2,000 feet wide and at a scale of one inch to 200 feet, using 5-foot contour intervals. Mr. Cook pointed out some of the difficulties encountered because of the lack of adequate control. He also emphasized the necessity of increasing the density of horizontal and vertical control along the routes of the proposed Interstate Highway System, now under consideration by Congress.

PROPERTY SURVEYS DIVISION

The Property Surveys Division contribution to the plenary sessions consisted of two papers describing property surveying methods and problems in two different North American regions.

Richard A. Mawhinney, property surveyor of Machias, Maine, in a paper entitled "Down East Surveying Problems—Coastal and Interior," described with "Down East" humor some of the surveying problems and methods peculiar to the eastern tip of Maine. He outlined present-day difficulties resulting from the fact that most original land-grant surveys in that region were made with the compass, and from the fact that these early descriptions did not, in many instances, anticipate physiographic changes with the passage of time and the consequent destruction of boundary markers and reference objects.

The second paper, entitled "Black Lake," was presented by Marcel Ste. Marie, Past President (1955) of the Canadian Institute of Surveying and Photogrammetry. The author, with the capable assistance of his charming wife, described the method which he, as a surveyor, employed in arbitrating a professional difference as to the ordinary high-water mark of Black Lake in Quebec Province. The precise location of this line, he explained, being also the boundary line between claims of rival asbestos mining companies, was of considerable importance because a difference of as little as one foot in elevation involved a horizontal displacement of 40 to 75 feet, or several hundred thousand dollars worth of asbestos ore.

Mr. Ste. Marie was introduced by C. C. Lindsay, Canadian member of ACSM's Advisory Council and one of the two surveyor-parties to the dispute.

EDUCATION DIVISION

The program for the second half of the Tuesday afternoon plenary sessions consisted of a panel discussion sponsored by the Education Division. The panel members discussed "What Teachers of Surveying are Doing Right—and Wrong." The Moderator was Harmer A. Weeden, Assistant Professor of Civil Engineering, Pennsylvania State University. The panel members were selected to represent the six Technical Divisions of ACSM. Robert H. Randall, Jr., of the U. S. Navy Hydrographic Office, represented Cartography. Professor L. V. Nothstine, of the Department of Civil Engineering of Michigan State College, represented Instruments. Hugh C. Clarke, Civil Engineer and Land Surveyor from Jersey City, N. J., represented Property Surveys. (Paul Rice read Mr. Clarke's prepared comments.) Daniel Kennedy, of the U. S. Geological Survey, represented Topography. E. D. Morse, of Houston, Tex., represented Control Surveys, and Prof. Eldon C. Wagner, of the University of Wisconsin, represented Education. A full report of this panel discussion will be published in SURVEYING AND MAPPING.

MAPS AND FLOODS

The first part of the plenary session on Wednesday morning, March 21, was given over to a discussion of the "Use of Topographic Maps in Flood Disaster Areas." President Lester C. Higbee presided and introduced the four men who told of their experiences in connection with recent disasters in their own localities.

Gordon E. Ainsworth, President of the Massachusetts Association of Land Surveyors and Civil Engineers, traced the events preceding and during the floods last summer in the New England area. Maps were

PANEL ON "MAPS AND FLOODS"

Left to Right: William C. Wattles, James A. Patterson, Gordon E. Ainsworth, and Tracy L. Atherton.

utilized in laying out distress areas and for showing routes of access or, more frequently, routes which could *not* be used because of washouts on bridges or low spots along the highways.

The second speaker was Tracy L. Atherton, of the California Division of Water Resources. Mr. Atherton stated that the topographic quadrangle sheets were indispensable in advising Civil Defense officials of pending flood areas. As levees failed, the maps were used to outline the extent of the area that might be flooded and alert Civil Defense people to begin evacuation of the area. The emergency use of the quadrangles represented only the start of their usefulness. These maps will be used for the study of levee realignment and by-pass construction to avoid the possibility of repetition of the damage caused by the floods.

The third speaker in this group was James A. Patterson, of the Bureau of Community Development in the Department of Commerce of the State of Pennsylvania. Mr. Patterson discussed the advisability of having the cartographers show on the topographic maps the areas which might be covered by streams during normal flood flows, such as had been experienced during the past 50 or 100 years. These would represent flood danger areas and a Planning Board could advise industries considering sites in such areas. Mr. Patterson told of many instances during the past 20 years when floods had occurred with considerable danger resulting. It would have been possible to have mapped the limits of these danger areas from local inspection even 5 or 10 years after the floods had occurred.

The fourth speaker to discuss the use of maps for flood control was William C. Wattles, Vice President of the ACSM, Civil Engineer and Surveyor, from Glendale, California. Mr. Wattles described the organization of the Los Angeles County Flood Control District, stating that at the present time the organization has about 1,000 members. Their basic problem is one of conservation, but maps are utilized to lay out the dams and channels to control and direct the flow of water in time of flood. The problems of forest fires and the excessive runoff, which result after the wooded areas have become bare, add to their responsibility. Of course maps are used in all phases of this work.

Following the papers describing the use of maps in flood control, Duncan M. Fitchet, Assistant to the President of Rand McNally & Company of Chicago, Illinois, spoke on the centennial celebration of Rand McNally. Mr. Fitchet gave a very interesting account of the growth of Rand McNally & Company and at the same time traced the development of modern means of transportation. Maps have played a very important part not only in the development of railroads, highways, and airlines, but in making their use appealing to the general public.

GENERAL ASSEMBLY

The plenary session was adjourned and a General Assembly of ACSM and ASP was called. Dr. Robert Randall, Honorary Chairman of the meeting, read a telegram which had been received from President Dwight D. Eisenhower. It was as follows:

"Mapping, aerial photographic reconnaissance, and photo interpretations have

played a vital role in modern military operations. Obviously our national security and our national prosperity owe much to specialists trained in surveying, mapping and photography, and to the techniques that have been developed in these fields. I am therefore delighted to wish the members of the American Congress on Surveying and Mapping and of the American Society of Photogrammetry an enjoyable convention and continued success in their professional work."

Dr. John J. Theobald, President of Queens College and Deputy Mayor of New York, then gave his keynote address. This address appears in full in this issue of SURVEYING AND MAPPING.

Technical-Division Sessions

Each of the six Technical Divisions held one or more separate meetings to transact the necessary business of the division and also to have the opportunity to discuss subjects of particular interest to the members of the individual division.

CARTOGRAPHY DIVISION

The Cartography Division meeting held in the Terrace Banquet Room of the Shoreham Hotel on Monday, March 19, 1956, was opened by Joseph P. Dunich, outgoing Chairman of the Division. After introducing the new Chairman and Directors for the coming year, Mr. Dunich turned over the meeting to Robert H. Randall, Jr., the new Chairman for 1956–57.

Mr. Dunich submitted the following report on the Division's accomplishments during his tenure of office:

The bylaws of the Division were revised to conform more closely to the bylaws of ACSM. Robert H. Randall, Jr., Chairman of a special committee, was assisted by Granville K. Emminizer and Cyrus Finley in making this important revision.

Membership in the Division was greatly increased through the efforts of William B. Sears and Arthur F. Striker. The current Division membership is 429. Mr. Striker, after determining the membership of the Division, developed criteria for maintenance of the Congress addressograph plates on a current basis. It is believed that other Divisions of ACSM could profit from a study of Mr. Striker's recommendations.

Dr. Arch C. Gerlach plans to publish a report on accuracy standards in mapping and charting as prescribed by the various mapping agencies in and out of government.

Dr. Walter W. Ristow was instrumental in increasing the quality and number of articles relating to cartography appearing in SURVEYING AND MAPPING during the year.

Through the untiring effort of the Program Committee Chairman, Granville K. Emminizer, Jr., the Division presented a fine program at the local Fall Meeting held December 8, 1955, in the Interior Department Auditorium in Washington, D. C.

The Division supplied expert guidance to many individuals and groups who asked for help in the solution of their cartographic problems.

Mr. Dunich concluded his report with words of commendation for the assistance given during the year by the Vice Chairman, Robert H. Randall, Jr.; the Secretary-Treasurer, Walter Alpaugh; Director Arthur F. Striker; and the Program Chairman, Granville K. Emminizer, Jr.

The following is a resumé of the activities of the Division on Cartography during the 16th Annual Meeting of ACSM:

The Division had the pleasure of presenting Rear Admiral H. Arnold Karo, Director, Coast and Geodetic Survey, who gave the opening speech at a plenary session of the Congress.

Admiral Karo was introduced by Lester C. Higbee, President, ACSM, and presented a paper entitled "World Mapping."

Three additional papers were presented at the Division's meeting, as follows:

Howard O. McComas, Chief, Cartography Section, Engineer Research and Development Laboratories, Fort Belvoir, Virginia—"Dimensional Stability Tests of Cartographic Materials."

Captain Donald H. Henderson, Chief, Development Branch, Relief Map Division, Army Map Service, Washington, D. C.—"Manual vs. Automatic Terrain Model Construction." This paper dealt with the mass production of plastic relief maps.

Colonel Richard W. Philbrick, Commanding Officer of the USAF Aeronautical

Chart and Information Center, St. Louis, Missouri, assisted by Captain Jack L. Frederick and Ivan T. Walters—"Cockpit to Chart—The ACIC System of Design and Development."

CONTROL SURVEYS DIVISION

The Control Surveys Division meeting was held on Monday March 19, 1956, from 10 a.m. to 12 noon and was presided over by Chairman E. D. Morse, of the Houston Lighting and Power Co., Houston, Texas.

Mr. Morse introduced the past chairmen of the Division, Prof. Milton O. Schmidt, Captain A. J. Hoskinson, R. M. Wilson, Captain H. W. Hemple, Carroll F. Merriam, and Colonel Floyd Hough.

The next order of business was reports by the chairmen of the various standing committees:

Membership Committee—E. J. Parkin. (Mr. Parkin was out of town so Albert Kalbfleisch presented the committee report.)

Program Committee—James B. Small.

Public Education Committee — Prof. Ralph Berry. (Due to a conflict of schedules Prof. Berry could not be present and no oral report was presented.)

Research and Development Committee—Julius L. Speert.

Technical Standards Committee—William T. Laidly. (Mr. Laidly was detained by bad weather. Charles A. Whitten presented the committee report.)

Nominating Committee—B. E. Beavin. (Mr. Beavin was not present, but the committee report was presented later.)

Robert G. Blanchard, New Jersey Department of Conservation and Economic Development, Trenton, N. J., was nominated for a 3-year term as member of the Board of Directors, starting Jan. 1, 1957. The other two members of the Board of Directors are Homer C. Fuller, Army Map Service, Washington, D. C., and Prof. Arthur J. McNair, Head, Surveying Department, School of Civil Engineering, Cornell University, Ithaca, N. Y.

After completion of the committee reports the following papers were presented:

"Program of Geodetic Control Surveys," by Captain Charles Pierce, Chief, Geodesy Division, Coast and Geodetic Survey. Captain Pierce outlined the needs for horizontal and vertical control in the early development of the United States and also outlined the modern requirements. The 100 mile spacing of arcs of triangulation and lines of leveling have been divided by 50-mile and 25-mile spacing, with a closer spacing of "area" development in some regions. Cooperative programs requiring special accuracies undertaken by the Coast and Geodetic Survey were outlined.

"Extension of Horizontal Control in Northern Alaska," by Charles A. Whitten, Chief, Triangulation Branch, Geodesy Division, Coast and Geodetic Survey. Mr. Whitten reported on the progress made during 1955 toward the extension of horizontal control in Northern Alaska. Survey parties of the Coast and Geodetic Survey and 30th Engineers cooperated in establishing approximately 1,800 miles of first- and second-order triangulation, most of it being on the Arctic slope north of the Brooks Range. The observations were adjusted within a few weeks after the close of the field season, using modern electronic calculators to make the necessary computations.

"Progress Report on Geodimeter Results," by Donald D. Mears, Electronic Specialist, Army Map Service, Washington, D. C. Mr. Mears reported on results obtained with the geodimeter by the Army Map Service during the past 2½ years. They have used the geodimeter with success under a wide variety of conditions of change in humidity, temperature, and elevation. When compared with taped base lines the agreement of the geodimeter results ranged from 1 part in 213,000 to 1 part in 780,000.

"Distance Measurements—One Million a Second," by Milton E. Compton, Manager Electronics Division, Berg, Hedstrom & Co., Inc. Mr. Compton described the operation of geodimeter Models 1, 2, and 3. The method of operation of Model 3 is basically the same as for Models 1 and 2. It is lighter and more portable but has less range and accuracy than the first two models.

The maximum range of Model 3 is about 20 miles with an uncertainty of about 4 inches in lengths measured.

The Division meeting was well attended and the active discussion period showed considerable interest in the papers presented.

The portion of the plenary session presented by the Control Surveys Division was on Tuesday March 20, 1956, from 11 a.m. to 12 noon. Chairman E. D. Morse presided and the following papers were presented:

"Accomplishments on Control Surveys in Canada, With Particular Emphasis on Shoran Program," by J. E. R. Ross, Dominion Geodesist, Geodetic Survey of Canada, Ottawa, Canada.

"A Suggested Code of Laws Regulating Land Surveying and Land Registration—A Proposed Plan of Control Surveys for the Property Surveyor," by Dr. John C. McEntyre, Associate Professor of Civil Engineering, Kansas State College, Manhattan, Kansas.

"Control Surveys and Photogrammetric Maps for Super-Highways and Toll Roads," by William R. Cook, Surveys Engineer, J. E. Greiner Company, Consulting Engineers, Baltimore Maryland.

EDUCATION DIVISION

The Education Division met as a group at two different times and on a third occasion sponsored one of the plenary sessions. The first division meeting dealt entirely with a discussion of the professional status of surveyors and mappers. A full report on this meeting is published in this issue of SURVEYING AND MAPPING. The plenary session sponsored by this division consisted of a Panel Discussion of "What Teachers of Surveying are Doing Right—and Wrong." This discussion will be published in full in a later issue.

The Annual Business Meeting was held on Tuesday afternoon, March 20, with Chairman Harmer A. Weeden presiding. The first item of business on the agenda was the selection of a Director to serve for a three-year term. Prof. Francis H. Moffitt of the University of California was elected. Two other directors, who have been elected previously and will continue to serve, are Prof. Sumner Irish from Princeton University and Prof. L. V. Nothstine from Michigan State College.

A motion was adopted that this division recommend to the Congress that ACSM co-sponsor with ASEE a summer surveying teacher's conference in 1957, if it is acceptable to ASEE.

For the remainder of the meeting there was a general discussion concerning the possible publication of the papers and remarks given both at the earlier division meeting and at the plenary session sponsored by the Education Division.

INSTRUMENTS DIVISION

The Instruments Division held its Annual Business Meeting, following the plenary sessions, Monday afternoon, March 19, with Chairman Talbert Abrams presiding. Abstracts of the three papers given under the sponsorship of the Instruments Division at the plenary sessions appear with the notes under the heading "Plenary Sessions."

The principal item on the agenda at the business meeting was the election of officers for the next year. Clifford A. Thorpe, Jr., of Thorpe-Smith, Inc., Falls Church, Va., was elected President. Raymond L. Sargent of Houston, Texas, was elected Secretary.

PROPERTY SURVEYS DIVISION

The technical session of the Property Surveys Division, held on Monday morning, with Gordon E. Ainsworth, Division Chairman, presiding, featured a Surveyor's "Town Meeting." Six well known surveyors, under the moderatorship of Prof. Ralph Moore Berry, of the University of Michigan, presented pet headaches and "gripes" encountered in their surveying work. Following the presentation of each "peeve," time was allotted for comments and discussion from the floor.

Ralph Kelsey, of Ralph Kelsey and Co., Cleveland, Ohio, began the discussion with a complaint against the necessity of expending considerable time, without compensation, educating clients, and in particular convincing title lawyers that legal titles are

valid even though they may differ from deed descriptions. Mr. Kelsey's remarks elicited considerable sympathy from the audience; a few members stated that they have made it a practice to charge clients for time thus spent; and others offered suggestions as to how the amount of time could be reduced.

Raymond T. Sargent, 1955 Chairman of the Texas Section, ACSM, the second speaker, described the difficulty that he, as owner of an instrument sales and repair business, has encountered in collecting fees for repair work. There is a considerable reluctance on the part of surveyors, he said, to recognize that repair fees, like all other costs, have necessarily risen in the past fifteen years. In addition, he said, surveyors generally do not recognize that today's more accurate and more complex instruments, such as the one-second theodolite, not only cost more initially, but are more expensive to maintain and repair. Mr. Sargent's remarks led to a discussion of the reasons why American instrument manufacturers do not make optical theodolites.

The third speaker, James T. Bell, of Kansas City, presented a solution to a problem rather than a "gripe." He explained how his firm had increased the efficiency of survey crews through the use of two-way radio and how, through the better liaison and coordination thus obtained, more crews could be economically employed. The floor discussion following his talk consisted largely of questions concerning details of the operation of the radios and indicated considerable interest.

Prof. Paul P. Rice, Rutgers University, Secretary of the Land Surveyors Division of the New Jersey Society of Professional Engineers, decried the apathetic attitude of the American Society of Professional Engineers toward land surveyors—the lack of assistance given toward professional recognition of land surveyors. He explained, however, that there is a possibility that the situation may be improved as the result of a program to be put on by the Land Surveyors Division at the annual convention of the national society at Atlantic City on May 26, 1956. The discussion which followed Prof. Rice's remarks was concerned with recognition of land surveying as a profession—separate and distinct from civil engineering.

As the fifth speaker, Prof. Berry introduced Arnold Lundgren of Illinois, one of the original organizers of the Property Surveys Division. Mr. Lundgren described, as his "pet peeve," the practice, by city planners, of employing the plat, and plat filing, as a means of controlling real estate and subdivision development. City planning officials, he explained, have often refused to accept plats for filing until or unless the parcels being conveyed meet with their approval. While not opposed to orderly development, Mr. Lundgren felt that some other means should be found to secure the necessary control.

William C. Wattles, ACSM Vice Presiden, of Glendale, Calif., instead of presenting a "gripe," suggested a system of filing for use by surveying offices which could well be the means of preventing a great many "gripes." The system described by Mr. Wattles, is for use in filing field notes, sketches, calculations, maps, and all other items, and is based on assignment of a job number to each project so that all items related to a given project can be indexed and filed in numerical order.

The first session of the Property Surveys Division business meeting was held Tuesday afternoon. Gordon E. Ainsworth, Chairman of the Division, opened the meeting with a short talk on some of the ACSM and Property Surveys Division activities and news of the past year. He mentioned in particular the part SURVEYING AND MAPPING is playing in providing unity to the organization and the growing interest of Canadian surveyors in ACSM, as manifested by increased membership and increased attendance at the annual meetings. He stated that during the past year two more States had adopted surveyor registration laws, making the total of States having such legislation now 34.

Victor H. Ghent, Secretary of the Division, stated that information as to the names and addresses of 1956 officers of other surveying organizations would be greatly appreciated so that the "round robin of in-

formation," begun last year by the Virginia Association of Surveyors, can be continued.

The Secretary also requested information on laws covering surveying for the States of Colorado, Florida, Indiana, Massachusetts, New Mexico, Oregon, and the Territory of Hawaii. These seven, he explained, were not covered in the article* in the journal. The information is needed, he said, in order to prepare and publish a supplement to the original article.

On a motion presented by Mr. Wattles, after explanation by the Secretary, the division voted unanimously to submit to the general membership at the business meeting to be held that evening, a recommendation that action be taken toward establishing salary and allowances for such ACSM officers as the Executive Committee may deem necessary.

After a great deal of discussion, the division approved a motion that the officers of the division discuss with the Chairman of the Membership Committee a proposal for a membership expansion drive, offering the services of the division and suggesting ways and means of effectively contacting surveyors throughout the country and of financing the drive.

Vernon D. George, Chairman of a Special Committee established the year before to investigate the possibilities of obtaining group coverage of error-and-omission insurance, reported on the activities of his committee. He reported that an organization willing to underwrite the insurance had been found but that, before group rates could be fixed and final arrangements discussed, his committee needed approval of ACSM Board of Direction to proceed and needed factual data as to the probable number of members who would be interested in coverage and the amount of coverage desired.

The following were elected as new officers of the division:

Gordon E. Ainsworth, *Chairman*
Vernon D. George, *Vice Chairman*
Victor H. Ghent, *Secretary*
Russell H. Brinker, *Editor*

* GHENT, VICTOR H., State Laws Defining Land Surveying, SURVEYING AND MAPPING, Vol. 16, No. 1, January–March 1956, pp. 14–19.

The second session of the Property Surveys Division business meeting, held on Wednesday afternoon, began with an open discussion of wages, hours, salaries, and other working conditions of field and office employees in various parts of the country. The discussion developed the fact that wages and salaries vary considerably in different parts of the country, principally as the result of variations in the supply of trained help.

As a second item of business, the discussion of the preceding day on the subject of insurance was resumed. The matter was finally brought to a close with a decision to continue the committee for another year, during which time an attempt will be made to acquaint all members with the matter through the journal and to obtain expressions of sentiment from both the membership and the Executive Committee of ACSM.

The final item of business was the passage of a motion that a committee be appointed by the Division Chairman to draw up a definition of a licensed land surveyor and a description of his duties. It was felt that this information, carrying the prestige of the ACSM, would be of great value to other organizations attempting to obtain surveyor-registration laws in States in which such laws do not yet exist.

TOPOGRAPHY DIVISION

The Topography Division met on Monday morning, with Chairman G. S. Druhot presiding. Charles H. Bechert, Director of the Division of Water Resources, Indiana Department of Conservation, presented a paper on "Indiana's New Mapping Program." It is only in the last few years, Mr. Bechert stated, that the value of good topographic maps has been widely recognized in Indiana. From 1923 to 1937, mapping bills were introduced in almost every session of the State legislature, but it was not until the disastrous flood of 1936–37 made the need obvious that any money was appropriated. Since that time, an increasing demand for maps to meet the needs for studies in water resources, community planning, highway expansion, industrial development,

and many other fields has arisen. The legislature has at last been convinced of the importance of topographic mapping, and it has approved a greatly expanded program which is now in effect in Indiana.

In a paper entitled "How Accurate is that Map?" Morris M. Thompson, U. S. Geological Survey, discussed the importance of accuracy specifications in topographic mapping, methods of expressing map accuracy, and possible improvements in existing specifications. Mr. Thompson stated the following conclusions: (1) existing accuracy requirements for topographic maps need to be clarified, but not tightened; (2) accuracy tolerances should be expressed in terms of standard deviation; (3) vertical accuracy tolerances should be a function of the ground slope; and (4) accuracy-checking procedures should be broadly standardized and made a part of accuracy specifications.

A paper entitled "What Topographic Maps Mean to California," was presented by Tracy L. Atherton, Division of Water Resources, Department of Public Works, State of California. Mr. Atherton described the current mapping program in California sponsored cooperatively by the State and the U. S. Geological Survey. Production is carried on fully by the Geological Survey while the State foots half the bill and handles its interest through a liaison office. An accelerated program, which has been in operation in California since 1945, has resulted in the mapping of 48 percent of the area of the State in the last ten years. In order to determine if California's mapping needs were being met by the published quadrangles, the State Engineer sent out a questionnaire in January 1956 to 1600 persons in key positions with respect to mapping needs. The answers received, Mr. Atherton stated, indicate that the appreciation of quadrangle sheets is universal among many different categories of map users, establishing the fact that the sheets adequately fulfill the broad general requirements for basic mapping.

Business Meeting

The Sixteenth Annual Business Meeting was held Tuesday evening, March 20, immediately following the travelog "Atlantic's Farthest Shores" narrated by Newman Bumstead of the National Geographic Society.

President Lester C. Higbee, who presided, opened the meeting with a general report on the work of the Congress. He then called on each of the division chairmen for brief reports, or comments, on their respective division meetings.

The Executive Secretary, Walter S. Dix, read the report of the Tellers Committee, which was as follows: President, Lester C. Higbee; Vice President, G. W. Herzog; Director for 1-year term to fill the automatic vacancy, William C. Wattles; Directors for 2-year terms, Robert O. Davis, Kenneth S. Curtis, S. P. Chapman, Victor H. Ghent, and Brother Austin Barry.

Mr. Dix reviewed the actions of the Board of Direction of ACSM which followed the Fifteenth Annual Meeting. He mentioned the passing of four important public resolutions, the granting of affiliation to the Indiana Society of Land Surveyors, and the approval of charters for the Colorado Section and the Louisiana Section of ACSM. Another important item reported by Mr. Dix was the culmination of a cooperative effort between ACSM and ASP for preparing a final draft of "Photogrammetry for Highway Specifications." These specifications were to be submitted to both the American Congress on Surveying and Mapping and the American Society of Photogrammetry for their consideration, adoption, and publication.

Captain Frank S. Borden, Chairman of the Membership Committee, reported that the present membership is 3,833 and predicted that it would pass the 4,000 mark this year. Announcement was made of citations to be presented to four of the members of the Congress for their cooperation in obtaining new members. These were Prof. Kenneth S. Curtis of Purdue University,

Prof. Francis H. Moffitt of the University of California, Tracy L. Atherton of the Division of Water Resources of California, and Richard B. Mecha from Wisconsin.

William C. Wattles, the retiring Vice President, brought greetings from California and told of the programs of the northern and southern sections of ACSM in that state.

J. H. Thomlinson brought greetings from and gave a report on the activities of the Texas Section. George Jones of New Orleans reported for the Louisiana Section. Colonel Stanley Borrell reported for the Colorado Section.

J. W. Herzog, better known as "Buck," the Vice-President Elect, also brought greetings from Texas. President Higbee called on the chairmen of the Publications Committee and the Editor for brief reports. The past presidents who were in attendance were recognized and George Harding, who recently returned from the Philippine Islands, spoke briefly to the group.

Gordan E. Ainsworth, Chairman of the Property Surveys Division, presented a recommendation from that division, that ACSM give consideration to some sort of compensation for the Editor, the Treasurer, Executive Secretary, and the Assistant to the Executive Secretary.

The final item of business was presented by Stuart Boyles of the Property Surveys Division. Mr. Boyles reported on the status of efforts to obtain a commemorative stamp for surveyors. As yet there has been no assurance by the Post Office Department that such a request would be approved.

There being no other business, the meeting was adjourned at 10:15 p.m.

Exhibits

The exhibits available for inspection by those attending the 1956 ACSM-ASP Consecutive Meetings and Co-Exhibit surpassed in number and in quality those of the 1955 meetings. A total of 83 exhibit spaces occupied by 63 commercial firms or government agencies displayed offerings of equipment, materials, and services.

It is planned to include in a later issue of SURVEYING AND MAPPING a detailed list of the organizations which exhibited at the meetings this year and to supplement this listing with brief accounts of the exhibits themselves. This change from the previous treatment of the exhibits[1] is being undertaken for at least three reasons: (1) to give the exhibitors something more in the way of recognition of their cooperation than a mere listing of names, (2) to provide those attending the meetings a little something in the way of notes to serve as refreshers for their memories, and (3) to show those not attending the 1956 meetings what they missed.

Social Activities, Ladies' Program

(EDITOR'S NOTE.—We are indebted to Mrs. Frank S. Borden for this report on social activities.)

The technical sessions of the recent successful ACSM-ASP Consecutive Meetings were interspersed, as usual, with diversions on the lighter side with the distaff contingent included. Such events are becoming traditional and are eagerly anticipated. The cocktail party in the evening of the opening day gave opportunity for many reunions among friends made at previous meetings, as well as extending that feeling of fellowship to many who were participating for the first time. Several hundred guests attended this pace-setting function and enjoyed delicious food and other refreshment, along with general sociability. Background music furthered the gala atmosphere, and dancing concluded the evening.

Tuesday, the ladies were free to "do" Washington shops, attend movies, or to do sightseeing generally, and in the evening attended the showing of the fine colored travel movie narrated by Newman Bumstead, a staff member of the National Geographic Society. This presentation, called "Atlantic's Farthest Shores," featured pictures of areas not often photographed by tourists and was made particularly interest-

[1] *See* SURVEYING AND MAPPING, Vol. XV, No. 2, April–June 1955, pp. 139–141.

ing by Mr. Bumstead's supplementary descriptions.

Wednesday proved to be the fullest day as far as planned activities were concerned. This being the overlapping day of the meetings of the two societies, many events were scheduled. The Fashion Show Luncheon at the Sheraton-Park Hotel was well attended, and showed those present what they might expect to find on a downtown shopping tour and where they might look for it. Gowns and shoes were among the featured items.

From the Sheraton-Park the ladies went to the Shoreham, where a very delightful tea was given in one of the large suites of the hotel. The hostesses were Mrs. L. C. Higbee and Mrs. W. S. Park, wives of the presidents of ACSM and ASP, respectively. This tea was sparked by further sociability and highlighted by a most entertaining and outstanding talk by Miss Louise Boyd, traveler and explorer. Because she has visited so many of the world's little-traveled areas, her talk was of especial interest, and her listeners thrilled over the graphic description of her breathtaking flight over the North Pole.

Wednesday evening, the banquet room of the Shoreham was the scene of the annual dinner. Nearly 500 persons, members of the two societies and their guests, enjoyed the fine food and excellent entertainment provided. An orchestra played throughout the evening and the professional acts presented were among the best in their fields, comprising singing, dancing, baffling magic, and one of the most talented xylophonists in the entertainment world. All this was presided over by a young and lovely local TV performer. Handsome door prizes included a large and de luxe Rand McNally globe.

Thursday, a motor tour was scheduled for visitors who wished to visit or revisit famous landmarks in the city. Each year similar tours have been made available. The evening was left free for individual choice of relaxation or entertainment, attention being called to the opportunity offered of seeing Cinerama, which is on view only in a limited number of cities.

Friday evening, the events of the week culminated with the annual ACSM-ASP dance in the Terrace Banquet Room of the Shoreham. There was a full orchestra to play for dancing, and tables were arranged for refreshments after the Night Club pattern. Nearly 500 guests availed themselves of this festive occasion. Prizes included a very fine Fairchild aerial camera, a painting by C. Earl Palmer, and an electric clock.

This brought the social program for the week to a very successful close, and old friends and newly-made ones parted with the thought of reunion, come another spring!

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Alibi For A Lost Motorist

Next time you get lost on a vacation trip and someone starts grumbling, there's but one thing to do.

Stop the car and calmly explain that according to the U. S. Geological Survey only about 37 per cent of the United States is adequately mapped. So there.

Such undisputed authority should squelch the most persistent back-seat driver or in-law.

This may be your gain, but Gerald FitzGerald, chief topographical engineer of the survey, wishes it wasn't so.

Postwar government water, mineral and highway programs "have caught us with our maps down," he confessed to the American Congress on Surveying and Mapping meeting in Washington recently.

Worse yet, the country won't be adequately mapped for another 17 years, he predicts. Seems that the current rate of mapping is about 4 per cent a year.

So don't feel too badly when you lose your way, for Uncle Sam will be groping around himself for a long time to come.

The above editorial from the Bluefield, W. Va., *Sunset News* is reprinted by permission.

100 Years and Rand McNally

By DUNCAN M. FITCHET

ASSISTANT TO THE PRESIDENT, RAND MCNALLY & COMPANY

IT IS a great honour to participate in your program today and to review with you briefly the events of the last century that have exerted such impact upon commercial mapmaking activities in America.

Bing Crosby, in a network radio broadcast, once said that "he was looking for a little uncharted lake where the fishing was so good that Rand wouldn't even tell McNally about it." George Gobel and Jack Benny frequently poke fun at our company name in their material. Even Sally Rand asserts that she chose her name from a Rand McNally map hanging on her agent's office wall. Tallulah Bankhead in her book says that she has played in towns known only to God and Rand McNally. It certainly is nice to travel in such *good company!* But we doubt very much whether we possess divine guidance, particularly when we are accused of hiring mental giants to make certain that none of the maps that we make can ever be refolded properly!! This is a distinction we seem to share with our friends at National Geographic.

Lindbergh carried a Rand McNally map on his famous Atlantic flight and said of his early air mail days, when pilots flew "by the seat of their pants" between Chicago and St. Louis, that there was no better navigational aid than a Rand McNally railroad map.

Today, Rand McNally is making about 250 million maps a year; and yet map sales represent only about one-third of our total printing and publishing activity. I feel compelled to say that we almost give our maps away—and that we make only a very modest profit on our other products!

And so it is that today our company name seems to have become a household expression that is synonomous with leadership in American commercial mapmaking. We covet such public confidence and seek continually to perpetuate this image of acceptance.

Even though we are celebrating our centennial with warm pride, we prefer to regard this longevity as a sign of business maturity rather than old age. Many of the firms that have survived this milestone eventually allow the past to dim their vision and foresight.

I should like, with your indulgence, to relive briefly some highlights of the past century; to reminisce; to review 100 years of achievement in surveying and mapping; and to take an objective look at accomplishments of the present.

The surveying and mapping profession and the commercial map industry have, in reality, reaped a 100-year harvest of the tremendous population movement and economic expansion within our country, in which they also were highly instrumental.

With the future as our sole objective, such thoughtful review may help us to see that the only difference between *stumbling* stones and *stepping* stones is in the way we use them. Surveyors and mappers may take just pride in the remarkable gains achieved by the men of deep insight who have preceded us. But we must be ever mindful of a famous remark made by Henry Ford:

> "Whatever you have gained
> You must either USE or LOSE."

I am confident that none of us will permit the family tree of American mapping to become "A TREE WHOSE BRANCHES SEEK THE SHELTER OF ITS OWN ROOTS."

We have distributed copies of a map of the United States as it appeared exactly 100 years ago—in 1856. There were 31 states in all! The West was still the land of the pioneer, and the Mississippi River defined the railroad frontier.

Presented at the Sixteenth Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., March 19–21, 1956.

Yet, traced across this map, from the Mississippi to the Pacific, are the routes of the four great transcontinental railroad surveys, just completed.

It was in 1856 that Horace Greeley said "Go West, young man, go West"—and many of the young and old were doing just that. One was a Bostonian, named William Rand, a printer by trade.

1856 was a year of beginnings! A lusty new political party had been born. It was a political year. In Illinois they began to talk of Abe Lincoln, a circuit rider and part-time attorney for the railroads. Lincoln campaigned vigorously that year for a national hero. This explorer and pioneer, John Fremont, who sought routes for the railroads, ran for president.

THE RAILROAD ERA

When Rand arrived in Chicago, he found a brawling city of mud streets, boardwalks and—even then—railroads. People already had big ideas of this city becoming the world's largest rail center. There were eleven systems serving Chicago and there was much agitation for a transcontinental railroad. It was in 1856 that the first railroad bridged the Mississippi. The conquest of the West had begun. This era of development and expansion, the greatest the world had yet to see, was to be charted by the surveyors and mappers of that day.

Our nation was on a timetable! All but the most desolate regions were soon to be within easy reach of the railroads. Chicago became the jumping-off point for the vast numbers of homesteaders and fortune hunters headed for the West.

In Chicago, that year, Rand opened his print shop. Later joined by Andrew McNally, they began printing railroad timetables and annual reports. To handle all the new passenger traffic the railroads needed lots of tickets—and fast. The success of Rand McNally was being established on a firm foundation of railroad printing—printing as diversified as the city and our land itself.

Rand McNally's entry into the map making field was brought about by the railroads. Our very first maps appeared in early editions of a Railway Guide published in about 1872.

It was logical, then, that Rand McNally would suggest the idea of using small strip maps in railroad folders and timetables to illustrate the various routes. More and more maps were used to guide eager homeseekers to their fortunes. Railroad maps were sold and given away by the thousands, just as highway maps are today.

Some of the railroad lines wanted their maps distorted intentionally to make curved routes appear as straight lines, as a competitive measure of enticing new settlers to the areas that they served.

Special maps, printed in different languages, were offered to induce new immigrants to travel west. These may have been partly responsible for the concentration of Scandinavian people in areas of Wisconsin and Minnesota.

The surge in new settlements certainly sold thousands of maps, but as more and more new towns were developed, a method had to be devised for making rapid corrections, inexpensively, to keep new editions up to date, and to make new maps as the need would arise. The face of our land was changing daily.

A technological change solved this problem when Rand McNally abandoned the expensive and inadequate methods of engraving and re-engraving on copper, steel, and stone. The wax-engraving process permitted insertion of correction patches in the printing plates. Maps could be corrected very quickly and reprinted frequently at but a small fraction of former costs. This, of course, gave great impetus to map sales.

This period of the middle 1800's saw the reduction and elimination of Western frontiers by the first of America's great transportation systems—and with it came an urgent need for survey and commercial mapping that was as relentless, new, and raw as the lusty West itself.

The saga of railroad pioneering and the opening of the West is accurately and vividly told in the many railroad maps and special guide maps prepared during the period. In 1856, San Francisco was the

largest city on the West Coast and a great seaport. It had a population of about 150,000 people. A small town on the southern coast of California, named Los Angeles, had less than 6,000 people, which made it smaller than the town of Gold Hill, Nev. Today, Gold Hill has 52 people.

By 1916, this era of great railway expansion came to an end and much new survey work had been completed. There were 254,000 miles of railroad in the United States. Pioneering by the railroads was finished, but an era of exploitation was just beginning.

THE AUTOMOBILE ERA

Meanwhile, another mode of transportation was making a noisy appearance on the American scene, conceived with confidence —amid backfires, dust, and mechanical breakdowns. The early automobile owners needed maps for the roads of that day were poor. Each individual became his own navigator, his own engineer, his own stage driver. It took a real adventurer to set forth more than 40 miles by auto. There were only a few gasoline and repair statoins, and most of the highways were unmarked. Motoring pioneers frequently were lost.

Unconfirmed legend has it that, in 1908, a honeymoon produced the first road map. As the story goes, Andrew McNally helped his new bride into his bright new Packard at the corner of Michigan Avenue and Jackson Boulevard in Chicago. With bride and camera, he set forth on the unmarked roads for Milwaukee, photographing with a big box camera every puzzling intersection along the way. Later, in the drafting rooms, black arrows were added to these photographs, indicating the proper turns to make. These photographs were reproduced with text and strip maps to make up the first Rand McNally Photo-Auto Guides. The Chicago to New York Photo-Auto Guide had over 200 pages and about 350 pictures. It sold for $5.00, but, for that price, it had the added advantage of showing alternate routes for wet and for dry weather. These were bulky books and very expensive to make.

In order to help the traveler, Rand McNally conceived the idea of tacking cardboard signs along the principal highways for route identification. This enabled us to use symbols on our maps to mark the highways and to eliminate the expensive pictures and clumsy format. These distinctive signs were printed in color, and waterproofed, using a different design for each highway. Some were bands of color, others combinations of letters and figures, or pictures, forming an insignia. Later, these markings were stenciled on the telephone poles because the cardboard signs made fine trophies for youngsters and were torn to shreds by the climbing spikes used by telephone linemen.

In 1915, Rand McNally developed the idea of a numbering system for highways. By 1917, the first numbered highway map was prepared, covering the areas around Peoria, Ill. A short time later, the roads in a part of southeastern Wisconsin were numbered and Wisconsin became the first state to adopt the same system for highway marking that is used today. The Federal Highway System got its start in San Francisco in 1925, when a joint board of State Highway Officials and others appointed from the Bureau of Public Roads met for the first time. Rand McNally assisted in these early efforts.

In that year there were a total of 20 million automobiles on the highways. Although the butt of some abuse in the controversial, early days, the "horseless carriage" had won the fancy of Americans, eager always for progress.

What is it that has made our people so travel minded? Perhaps it is our heritage of immigration. Whatever the cause— Americans are no respectors of distance. With 60 million cars on the road today, we are determined to be the most mobile people on earth; and we use, in full measure, our fine transportation facilities. Americans travel over one-half a trillion miles each year. During 1955, each man, woman and child averaged about 5000 miles by automobile alone. But even with our refined system of road markings, the need for charts of our now complex pattern of highways

has increased. Our company alone produces nearly 70 million road maps each year for free distribution by oil companies and State highway departments.

THE AIRCRAFT ERA

Aviation, our third great miracle of travel, has changed our concepts of space and time. In a brief half-century, mass air transportation is now a reality and supersonic speeds are commonplace. Perhaps more meaningful than the technical accomplishments, it has turned the minds of the American people and brought realization that distant, foreign shores are now very close indeed. Aviation has changed our sense of direction, too, and gradually, it is affecting our ideas of what a map of our world should look like.

Like the railroad and the automobile, it at once offered expanding markets for new maps, essential for navigation, and maps to inform the public of new services.

But during the first 10 years of commercial air transportation there were virtually no maps or charts to aid the flyer in finding his way. In 1928, out of a sense of responsibility to American travelers, Rand McNally was first to publish a set of Air Trails Maps covering the entire United States. The demand for these maps was limited, indeed, so to encourage dealers to stock these new maps, we used as a base a set of standard State maps which were well accepted throughout the country, and added an overprint of appropriate air navigational aids. These maps proved to be very costly to maintain because new airports were being constructed everywhere and existing ones enlarged or changed. We happily discontinued this program when the Coast and Geodetic Survey set up specifications for the U. S. Sectional Aeronautical Charts in the early 1930's.

Real air-travel progress came about as a direct result of World War II and efforts in the years immediately following. In the brief period since 1940, domestic air travel has expanded 10 times, and our airlines now carry over 30 million passengers annually.

C. R. Smith, President of American Airlines, and one of the early pilots to use our Air Trails maps, addressed our Centennial Assembly in Chicago in January. To illustrate the tremendous developments in air transportation, he pointed out that in the 20-year span between 1940 and 1959, planes carrying 20 passengers at 150 miles an hour are to be contrasted with jet aircraft that will carry 120–150 passengers from New York to Los Angeles in 4½ hours—at cruising speeds of 550 miles an hour.

Chicago, already the world's greatest rail hub, is also the world's largest air center, with a commercial flight arriving or departing at the rate of nearly one a minute—24 hours a day. Domestic air travel now exceeds all first-class rail traffic, and International air travel now exceeds overseas traffic by ship.

All of this bears witness to the changes in all map activity brought about by forward thinking men of aviation. The combination of domestic and foreign air travel, of course, has opened new markets for commercial map products. Airlines, like the railroads, want attractive and informative map coverage of the areas that they serve. And with it, of course, comes a new demand for maps and guides of foreign countries.

Not only has the airplane stimulated new map sales, but, like the railroad and the automobile, it has brought revolution in the techniques of mapping.

Early in the game, alert mappers were quick to visualize the impact of aerial photography and photogrammetry. What was called the "map science of the future" only a few years ago, is, today, a rapidly expanding new phase of our industry.

Revolution is probably the most appropriate descriptive word. Wholesale mapping from aerial photography has greatly accelerated our large-scale mapmaking potential and our accuracy; it has drastically improved the economics and cost structures of our field and has altered our manpower requirements.

And yet, I suspect we are but at the threshold of even greater technological progress. The pace is ever increasing. Visualize, if you will, the challenge to the

mapping field which transportation of the future will hold.

Special maps may be needed for helicopters that may soon compete with the automobile for private transportation. What of rockets? What is to be the challenge of space travel? The opportunities and the problems are nearly beyond comprehension. Certainly more maps will be needed than ever before. Maps of types not yet conceived. Our present techniques will be obsolete, of course. Such air travel will require a degree of accuracy, of preciseness, not yet practical with our best methods today.

We say the pace of mapping is on the increase. There is little doubt about that! So is the tempo of American living. And these two factors combine to present problems which are unique to the commercial mapmakers. While we at Rand McNally devote much effort to making new maps for specific customer needs—for atlases, for schools, for travel and for business—our greatest work volume is in maintaining the many editions of our maps in up-to-date form. Americans have always been active in their demands for up-to-date maps.

CHANGE REQUIRES REVISION

Europeans will cheerfully accept a map or atlas that is 10 to 15 years old without hesitation! But Americans, anxious to keep pace with events, will write long, critical letters if someone's home town is omitted, a newly-established post office not shown, or a new boundary change not reflected in our maps.

The flourish of new changes, new towns, and moving boundaries have kept us busy with map revisions every year and have required a unique production organization. A single road map, for example, which may be reprinted two or three times during the year for a single oil company, may require as many as 1,500 corrections a year; not because the map was in error when printed but because of name changes, new road alignments, new mileage figures, changes in the surfacing of roads, etc. Ours is a heritage of keeping pace with the dynamics of American growth, and each new map or atlas reprint must reflect all the modern changes.

Anyone who thinks the American geographical scene has now become fixed in a permanent mold should see the work involved in keeping our indexes up to date. One product, our Commercial Atlas, may require as many as 150,000 changes each year. This particular product gives complete detail on all railroads.

In addition to the production of maps, we find frequently that we must give travel hints to tourists. In connection with our road-map making, we operate tour bureaus for a number of our oil-company customers. We get many unusual requests for more information than is normally shown on a map.

Once an expectant mother wanted to know the best automobile route to the West Coast, but she wanted to be sure that she would never be more than 100 miles from the nearest hospital.

Another time, a pair of rather elderly ladies wished us to give them the best highway route between Chicago and San Francisco. The one stipulation in their request was that if we were to route them through the mountains along highways that had steep cliffs at the sides, we should make certain that they would always be on the inside lane!

In order to keep our atlases up to date, we find it necessary to develop populations for many places not provided in the U. S. census. Our complete index of places in the United States includes a total of 119,129 cities and towns. The most recent census provided populations for only about 18,000 places. Thus, in order to supply these populations, we conduct a private census of our own. Each year we send out thousands of cards to these various communities, seeking population estimates. Not all of the cards come back, and sometimes amusing reports are returned to us. One from a postmaster in Michigan said that the total population of his town was 4,003, including himself, his wife, his hound dog, and 4,000 snowshoe rabbits.

Keeping maps of foreign countries up to date poses a real problem for the mapmaker. One of our biggest headaches is

keeping abreast of the territorial changes and deciding when and how to recognize them. Wars do not make the only map changes, for political alterations are taking place continually. Some of these are pretty tough to handle. We have to be realists. In the role of a neutral reporter, we can take no political stand. Businessmen and tourists—our customers—must know with which government they will have to deal. Because of this, we tend to show *defacto* situations, in other words, those which actually exist. Those having political disagreement with the way areas may be shown sometimes call this "conquest by cartography." It is clearly evident, however, that the geographical and political information shown by Rand McNally on its maps is important and highly regarded by the people in our government and by the courts of our land.

THE PAST AND THE FUTURE

In reliving the highlights of Rand McNally's 100 years of history, we have seen what impact the changes in transportation have had upon our country. No single factor of our business and social life has played a greater part. Certainly we may trace the growth and expansion of our country as it has been recorded by surveyors and cartographers who have kept pace with transportation. Maps have been chronicles of the times!

We have cited two great technological changes that have revolutionized mapping technique, making possible low cost reproduction and the resulting wide public usage. Wax engraving, in its time, took map reproduction out of the realm of the carriage trade and made it possible for Americans to have new maps nearly as quickly as they had news itself.

Air transportation has been a unique stimulus. Probably most significant to all facets of mapping have been the cartographic achievements made possible by photogrammetry.

But Printer Rand and Printer McNally would want us to pay tribute to men in photography and lithography as well. Certainly modern offset lithography is a medium ideally suited to high quality reproduction with unique and attractive color treatments at reasonable cost. Lithography has aided in the evolution of new drafting procedures. Plastic scribing holds tremendous promise for the future. Although the months and years ahead will bring needed refinements in materials and techniques, the process has gained world recognition for its high quality and cost-saving characteristics.

We would be remiss, indeed, if we failed to set our sights on improved cartographic techniques for the future. I believe history and past experience are important only as they influence better decisions in the future.

The day may never come when automation will apply to map drafting and reproduction. Nevertheless, great strides can be made to achieve work simplification. At Rand McNally we have embarked successfully upon time- and motion-study work, cost analysis, and standardized methods and procedures. Although it promises to be a long road, we feel this program to be an essential element of self-analysis that will provide our customers with the best possible product at the least possible cost. This frame of mind is, in every sense, a duty and an obligation that all of us share alike. Whether in private industry, education, or government, men of responsibility are committed to a policy of extended effort for improvement.

It seems to me that the American Congress on Surveying and Mapping provides the ideal vehicle to bring together the best minds of education, business, and government for direction in the years ahead. This fine association has done much to further the field of surveying and mapping, not only as a profession, but by urging resoluteness and progress.

In a field which still is essentially one of hand labor, we must make every effort toward continued technological advancement. Under the aegis of this Congress our technicians of field and plant now have the opportunity to disseminate knowledge and experience for the benefit of all. The industry itself and, more important, the American public, loses out by duplicate experimentation and needlessly retarded advance-

ment. Certainly our governmental map agencies, which are the finest in the world today, might make even greater strides, in their leadership, by pooling their best experimental facilities and research personnel towards the solution of common objectives. The Congress itself might give thought to the creation of a research and development establishment to be supported actively by the membership, for the refinement of new techniques and testing and developing of processes and products.

Our past has been great because men of vision sought accomplishment with each opportunity for increased service to the American people.

Our future is made of "todays." Each day brings the opportunity to make tomorrow better. We must not only be ready to take each new opportunity, we must make these opportunities.

I am confident that whenever that rocket for the moon is ready to depart with a load of paying customers, the American mapping profession will have been able to furnish accurate charts for navigation in outer space. Rand McNally, God willing, will prepare the maps that those space pioneers can use to follow their journey.

Personnel Changes in USGS Topographic Division

A number of changes in the top jobs in the Topographic Division have been approved by the Director of the Geological Survey and were announced recently by Gerald FitzGerald, Chief Topographic Engineer.

George D. Whitmore, formerly Chief, Research and Technical Control Branch, becomes Deputy Chief Topographic Engineer, a newly created position.

Charles H. Davey, formerly Chief, Topographic Surveys Section, Research and Technical Control Branch, becomes Atlantic Region Engineer, replacing Robert H. Lyddan, who has recently been named Assistant Director of the Geological Survey.

R. H. Moore, formerly Chief, Photogrammetry Section, Pacific Region, becomes Chief, Research and Technical Control Branch, replacing George D. Whitmore.

Robert O. Davis, formerly Rocky Mountain Region Engineer, becomes Pacific Region Engineer, replacing Conrad A. Ecklund, who retired April 30, 1956.

James M. Lawson, formerly Chief, Field Surveys Section, Rocky Mountain Region, becomes Rocky Mountain Region Engineer, replacing Robert O. Davis.

Jesse C. Mundine, formerly District Engineer, Rocky Mountain Region, becomes Chief, Field Surveys Section, Rocky Mountain Region, replacing James M. Lawson.

Dwight H. Rutledge, formerly Assistant Pacific Region Engineer, becomes Chief, Field Surveys Section, Pacific Region, replacing Roy R. Monbeck, who retired April 30, 1956.

John A. Law, formerly Assistant Chief, Cartography Section, Atlantic Region, becomes Chief, Topographic Surveys Section, Research and Technical Control Branch, replacing Charles O. Davey.

Roy F. Thurston, formerly Chief, Production Control Section, Plans and Coordination Branch, becomes Assistant Pacific Region Engineer, replacing Dwight H. Rutledge.

Channing Van Camp, formerly Assistant to the Chief Topographic Engineer, a position which has been abolished, becomes Chief, Production Control Section, replacing Roy F. Thurston.

G. Stanley Druhot, Chief, Planning Section, Plans and Coordination Branch, becomes Special Assistant to the Pacific Region Engineer, a newly created position.

Robert E. Altenhofen, formerly Chief, Heavy Plotter Unit, Atlantic Region, becomes Chief, Photogrammetry Section, Pacific Region, replacing R. H. Moore.

Harold Williams, formerly District Engineer, Atlantic Region, becomes Chief, Planning Section, Plans and Coordination Branch, replacing G. Stanley Druhot.

Edward A. Krahmer, formerly District Engineer, Atlantic Region, becomes Chief, Equipment and Procurement Planning Unit in Program Control Section, Plans and Coordination Branch, a newly created position.

The Future of Your Profession Rests With You

By Dr. JOHN J. THEOBALD

PRESIDENT OF QUEENS COLLEGE AND DEPUTY MAYOR OF NEW YORK

MR. CHAIRMAN, Ladies and Gentlemen, I am happy to be with you today and to have this opportunity to greet Bob Randall and so many of my other old friends and acquaintances.

Dr. JOHN J. THEOBALD

When I left Washington and my formal association with Federal mapping efforts about 1941, the American Society of Photogrammetry was less than 10 years old, and the American Congress on Surveying and Mapping had just been started. In those days, we were talking about the photoalidade, Tom Pendleton and the Geological Survey's relatively recent applications of multiplex equipment to precision mapping, and the new nine-lens camera of the Coast and Geodetic Survey. Down at TVA, George Whitmore and his colleagues had been demonstrating the effectiveness of aerial methods for property surveys, and the big debate centered around the relative merits of glass versus copper-plate engraving. Incidentally, for those who do not understand me, I hear they now call it "negative scribing."

Today this seems like a long time ago and so I think you can understand that when I scanned your present program, I was particularly interested in identifying what new trends it indicated. This is what I found. First, there were the usual and to be expected technical papers—"Automatic Contouring"—"Pendulous Cantilever Principles Applied to Self-Leveling Instrument Design"—"Distortion Tolerance Specifications for Mapping-Camera Lenses" and the like. A little more complicated perhaps, a little more varied, but, basically, marked evidence of the same scientific advances which were being made then and which are obviously continuing at a thoroughly healthy rate.

There were also two other types of papers amply represented. There was a group which we might refer to as those devoted primarily to the service functions of mapping and photogrammetry—"Surveys of Flood-Damaged Areas in New England"—"Correlations between Terrain and Human Activity which may be analyzed by Photo Interpretation"—"Control Surveys for Super Highways and Toll Roads—"Several Uses of Air Photo Interpretation to the Soils Engineer"—"What Topographic Maps Mean to California." Papers of this type, if they were written at all, twenty years ago would probably have consisted largely of

Presented at the Sixteenth Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., March 19–21, 1956.

attempts by one mapping agency to prove that the methods and techniques which they had developed for their particular and frequently limited purposes were distinctly the best, and cheapest, for all uses. Oh, we admitted, strictly among ourselves, that this was not valid, but in the light of the limited understanding of the new mapping methods, we would hardly have admitted it publicly for fear of its effect on departmental budgets. Today, judging by both the number and the character of such papers being presented here, there is apparently a wholesome, objective, professional interest in applying newly developed tools most effectively to an ever broadening horizon of activities and uses.

The third group was, as I look back, probably stifled during the late 1930's by a combined awareness of the woeful inadequacy with which our own country was at that time mapped, and our acute consciousness of the pending threat of war. Bob Randall and a small group of coworkers were beginning to develop a Pan American interest in coordinated mapping of the Western Hemisphere, but projects with a broadly international flavor, such as the papers on "Mapping the Antarctic Continent" and "World Mapping" were not yet in the public eye.

To my mind all of this adds up to just one thing, surveying and mapping, in the strictly professional sense, has come of age. No one would question its high intellectual level or the integrity of its practitioners. Here at these sessions is ample evidence of the sharing of knowledge and scientific advance, evidence of public service through research, and proof of a sense of obligation to society as evidenced by the many efforts to extend the use of the tools of the profession to the increasingly greater service of man. These are the hallmarks of a profession.

Status as a profession, however, brings with it special responsibilities. In the early stages of a profession's growth, its practitioners are likely to come to it from a variety of technical and cultural backgrounds. The new area of knowledge develops primarily because each of these men has special skills of an unusually high order, great vision, keen intellectual capacity, and an undying faith in the pursuit of an idea. The chance circumstances, which bring such giants as these together in a new and common interest, happen infrequently. Spontaneously it seems, they develop a new science and uncover heretofore unrecognized principles, but there comes a time when new people must be specifically trained and educated to carry the new profession on, or it will die.

This is the stage at which surveying and mapping, or perhaps I should say the cartographic sciences, has now arrived, and this is the subject about which I should like to talk with you briefly today.

At one time surveying was the core of civil engineering curricula. Even licensewise the civil engineer and the surveyor were practically one. As our knowledge of the strength and mechanics of materials, of stress analysis, and of hydraulics increased, the early emphasis on mapping and land measurement gradually gave way to the applications of structures, sanitation, transportation, and fluid flow. This trend away from surveying was further augmented by an increasing awareness that engineers, if they were to be of maximum service to society must also be given a broad cultural and social background.

This, in a sense, was an attempt to return tc the traditional liberal-arts concept of pre-professional education, and most of our engineering schools are still struggling with makeshift attempts to squeeze both a liberal-arts base and adequate professional preparation into four baccalaureate years.

Academically there have, of course, been many casualties on the way. One of the results of this two-way squeeze has been to reduce the credits and course offerings in surveying to little more than a token in most civil engineering programs. This may be lamentable from our standpoint, but, in the light of the intense scientific advances and the broad areas which civil engineering now encompasses, even we could hardly expect more from the average typical civil curriculum.

Educationally, there are only two prac-

tical paths which might be followed. One would be to establish a major or option in "Surveying, Geodesy, and Photogrammetry" similar to those which now exist in highways, structures, sanitation, and the like. The other would be to fashion a new curriculum pointed specifically at the professional needs of this relatively new field.

Both of these approaches have been tried to a limited extent, and in terms of the immediate present either one of them would probably do. But, as we look ahead to new developments, it seems to me that only the latter can possibly be satisfactory in the long run. Let me tell you why.

To begin with the present options in civil engineering stem in general from an expanded knowledge of mathematics, mechanics of materials, fluid mechanics, or a combination of these coupled with other sciences such as chemistry and biology. In contrast, cartography takes off from a basic knowledge of mathematics—particularly plain and spherical trigonometry, geodesy, and optics. Clearly both are applied sciences, and, as such, technically engineering. Both build their technical knowledge upon mathematics and physics as a base, and both need a knowledge of elementary surveying. But there the similarity stops.

We have already reached the stage where the professional in surveying and mapping, in addition to an understanding of the basic use of the level and the transit, will certainly need some specialized preparation in such areas as geodesy, geophysics, photogrammetry, electronics, and optics. These have become the technical tools of mapping, and they would have to be preceded at least by basic physics and mathematics and, perhaps, by some chemistry.

In addition to all of these advances, improved transportation and communication are rapidly reducing the effective size of the world and, in the process, increasing our interest in and concern for more adequate and precise location of far off places. To say the least, this will create a most important international role for the mappers of tomorrow. Just as our surveyors of the 18th and early 19th centuries were in a sense, for better or for worse, our early ambassadors into the Hinterland of the West, so too will our geodesists of tomorrow necessarily be in the forefront of those bringing a better understanding of our American culture to foreign lands and giving us in turn a greater appreciation of our American, European, and Asiatic neighbors. As professionl people, therefore, it is particularly important that their education be not limited to the scientific aspects but include a broad foundation in the humanities and social sciences, with particular emphasis on an adequate understanding of the world-wide scene.

Such a curriculum would most certainly require at least four full years, and a considerable number of students should probably go on to graduate work in order to do it full justice. Certainly there would be little time and little need for many of the subjects which most engineering faculties would consider a minimum essential to any degree in civil engineering. As a civil engineer, I certainly realized that a civil engineer still needs some surveying, but this is not the point. The cartographic sciences and civil engineering are no longer the same thing, and any attempt to keep them so only succeeds in providing a diluted version of both.

I recognize that at this stage numbers of students and numbers of jobs will of course be small. Fortunately, however, most leading colleges and universities could draw upon existing courses for the non-technical phases of such a program and even for the basic mathematics and science work. Under these conditions it should be possible to develop independent curricula, provided colleges are reasonably careful about unnecessary competition among themselves. This, it seems to me, is certainly something about which your societies should deeply concern themselves.

There is another phase of the problem which we must keep in mind. A good many subprofessional people are needed to keep one professional fully occupied with professional work. College enrollments are rising at a startling rate. They have already reached 2,500,000 and on the basis of children already born will go to 5,000,000

or more in the next ten or fifteen years. This is a distinct shift from college education for the few to college education for the many. If prelimniary indications and our experience with the similar shift in high school education during the first quarter of this century mean anything, we shall see the growth during this period of many new curricula of less than four years, tailored specifically to meet the special needs of a much broader cross section of our society.

With our growing recognition of the need for balanced teams of professional men, technicians, and skilled craftsmen, many if not most of these will undoubtedly be pointed toward the demand for technical and subprofessional personnel. As our modern surveying and mapping moves into full professional status, we too will have to give considerably more attention to the development of an adequate supply of such technicians if we are to use our manpower to its fullest measure.

As we look ahead, it seems to me that the time has come to urge the creation of a limited number of special four-year programs in what might be broadly termed "geodetic science." The present offering at Ohio State University is an excellent example of this. In addition, we might well be fostering a somewhat larger number of two-year terminal programs designed to provide the variety of technically trained people needed to round out the picture and provide the balanced team. Furthermore, in the light of the relatively limited employment opportunities which at present exist, these programs must be carefully planned and coordinated. Individual colleges can be asked to prepare and administer curricula, but no single college can be called upon to undertake the coordinating function. Rather, this is the responsibility of the professional societies.

Over the past 25 years you have fashioned a new profession, but history is replete with skills which died with their creators. The future of this profession still rests with you. You must see to it that there are properly-qualified young men to carry on what you have started.

Aero Service Corporation Undertakes a Variety of Projects

Nearly one-fourth of Saudi Arabia will be mapped from the air in the course of a project already begun by Aero Service Corporation, Philadelphia, Pa. The project, which involves covering an area of about 200,000 square miles, is being financed by the Saudi Arab government. By the middle of March, approximately 65,000 square miles had been photographed. The project will be closed down from April to September on account of adverse weather conditions, but the work is scheduled for completion in 1957.

The photo-maps to be produced by the survey will be at a scale of 1:50,000. Shoran will be used to control the mapping flights, four Shoran stations being used to guide and track the plane. The crew includes over twenty technicians and engineers to fly the plane, operate Shoran equipment, and process the exposed film.

A detailed survey of a ten square mile area for the city of Salisbury, N. C., was also undertaken by Aero Service Corporation. The photography required but one day of flying and was completed on March 9th.

Photo-maps to a scale of 1:4,800 and detailed topographic maps at a scale of 1:1,200 (with a two-foot contour interval) were scheduled for delivery within twelve weeks.

Salisbury is the fourth North Carolina city to contract for new maps in recent years. Durham completed its mapping program in 1951, Raleigh in 1952, and Greensboro in 1955.

Another project, in Cuba, involves an airborne magnetometer survey for Cuban Stanolind Oil Company, with a twin-engined Beechcraft carrying the magnetometer over a series of gridded lines at two-mile intervals and a flying height of 1,000 feet above the ground.

Isomagnetic maps with a five-gamma contour interval and a horizontal scale of 1:50,000 will be compiled from the data obtained.

Photo-maps, planimetric maps, and isomagnetic maps are all scheduled for delivery in the fall of 1956.

Tacheometric Surveying

Methods and Instruments

By WILLIAM MUSSETTER

ARMY MAP SERVICE

THE WORD "Tacheometry"[1] is derived from the Greek, *tachys*,—rapid, and *metria*,—measurement. It signifies simply a rapid measurement. By a liberal interpretation the term could be extended to cover any branch of surveying which affords a manner of obtaining distances rapidly. It is now generally understood to mean those operations in which distance is obtained from one position of the instrument through the fixation or measurement of a small angle lying opposite a known base.

The stadia-intercept method which is well known to American surveyors is a typical example of tacheometry. Other methods of tacheometry have not come into any widespread use in the United States. There are various reasons for this. Among them are the general confidence in other established methods, the lack of domestic specialized instruments, and, perhaps, professional inertia. At the present time, however, there appears to be considerable interest in more rapid and economical methods of surveying, especially in the fields of topography and control for photogrammetry. The purpose of this article, which will be presented in two installments, is to describe the principles of tacheometry and the operation of some of the available instruments in order that the surveyor may better judge their merits in application to his problems.

The development of tacheometric equipment is much further advanced abroad than in the United States. Some of the European instruments are very ingenious and, having become available here, may well find a field of usefulness even though American conditions are often quite different from those prevailing in Europe.

The tacheometric method is not new. The first known proposal of it is attributed to the English astronomer, William Gascoigne, in 1639. The origin of the stadia micrometer is generally credited to James Watt, who used it in Scotland as early as 1771, although there is some evidence that this device was known in Italy and France prior to that date. Watt was undoubtedly the first to apply optical methods to produce the stadia displacement. Eckhold's self-reducing Ominmeter was patented nearly 100 years ago.

The modern version of the subtense methods was reintroduced near the turn of the century by Col. H. C. B. Tanner of the British Army. Many others have contributed to the development of tacheometric methods and the design of instruments both in earlier and in recent times.

Since it is very desirable that the tacheometer serve other purposes of the survey, it has taken the form of a theodolite or transit modified by the addition of optical or mechanical distance-measuring devices. In many cases it includes self-reducing devices for finding the horizontal and vertical components of the distance, as well. The solutions are accomplished in various ways. In order to describe them adequately, they are taken up individually in the descriptions of representative instruments.

Tacheometric instruments may incorporate the base within their structures, or make use of a detached base. The common example of the internal base type is the military rangefinder. Because of its necessary size, this type instrument is seldom useful to the surveyor, although one or two small designs have found some favor in special classes of topography.

The other instruments, which utilize a base external to themselves, may be divided into two groups;

[1] Also "Tachymetry," perhaps the proper etymological form.

(1) Those which measure an intercept on a distant staff by means of a fixed parallactic angle.

(2) Those which measure the angle subtended by a fixed base.

The latter classification is usually referred to as "Subtense." Only the instruments which employ a fixed parallactic angle will be described in this installment. The subtense method will be discussed in a later issue of SURVEYING AND MAPPING.

The fixed-angle instruments divide into three classes;

(1) Stadia instruments which intercept a portion of the length of the staff by two rays which include the fixed angle.

(2) Double-image type tacheometers which cause a portion of the image to be displaced with respect to another, the linear displacement being read from a graduated staff.

(3) Tangential tacheometers

A vertical or a horizontal staff could be used with either type instrument. However the dictates of design have led to the use of the vertical rod with the stadia and tangential types, and the horizontal staff with the double-image type with but few exceptions.

THE STADIA-INTERCEPT METHOD

Since the ordinary stadia is well known to surveyors, it may be used in illustrating some of the principles that apply to other methods as well.

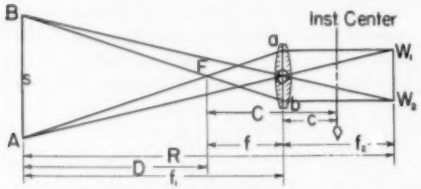


FIGURE 1.—The stadia diagram

NOTE—In the above diagram it is apparent that the dimension line for R has been carried too far to the right. It should have stopped in the vertical line through the instrument center.
—EDITOR

Figure 1, a diagram familiar to all students of surveying, illustrates the principle of the stadia which depends on the ratio of the principal focal length of the objective lens to the interval between two wires placed in its focal plane. A and B are the points on the rod intercepted by the rays through the threads W_1 and W_2. The interval between A and B is the rod intercept, S. F is the external focal point of the objective, O. The distances from the objective to the rod and the image, respectively, are indicated by f_1 and f_2, while f is the principal focal length. The desired distance is R, between the rod and the instrument center.

By similar triangles involving the principal rays through 0,

$$\frac{f_2}{f_1} = \frac{i}{s}, \text{ or } f_2 = \frac{f_1 i}{s}$$

Also, from the equation relating to the conjugate focal distances of a lens,

$$f_2 = \frac{f_1 f}{f_1 - f}$$

Therefore

$$\frac{f_1 i}{s} = \frac{f_1 f}{f_1 - f}, \text{ or } f_1 = \frac{f}{i} s + f$$

The quantity $f \div i$ is the stadia ratio. Denoting it by k, we have

$$f_1 = ks + f$$

The distance, R, is equal to $f_1 + c$, c being the distance between the entrance node of the objective lens and the instrument center. The value of c is not strictly a constant in the case of a telescope which is focused by moving the objective. For sights of ordinary lengths this variation is small and can be neglected. The sum of $f + c$ can then equal a constant, C, and the equation becomes,

$$R = ks + C, \qquad (1)$$

the form generally known to the surveyor.

Equation (1) may also be derived analytically from figure 1. By the laws relating to refraction in lenses, rays from A and B which pass through F will be parallel after passing through the objective. Hence, $ab = W_1 W_2 = i$. From the two similar triangles whose vertices lie at F,

$$D = s \frac{f}{ab} = s \frac{f}{i} = ks.$$

Since the rod distance, $R = D + C$,

$$R = ks + C, \text{ as above.}$$

The term C is known as the stadia constant. This constant is present in some degree in all standard optical systems which set up similar triangles, one of which is based on the focal length of the objective lens.

Many efforts have been made to eliminate the stadia constant. The first solution was offered by Porro in 1823. He designed an objective system composed of two positive lenses placed at a fixed distance apart. By proper dimensions, the point from which ks is measured[2] was transferred to the instrument center. While this completely eliminated the constant, the telescope suffered the disadvantages of increased length and cost. This objective system was applied to many British instruments but the design has since been abandoned.

The internal-focusing telescope has now come into general use. In this construction, the distance from the positive element of the objective to the reticle is fixed. Focusing is accomplished by the movement of a negative lens placed between the positive lens and its principal focal point. This movement effects a change in the equivalent focal length of the objective system, the focal plane remaining fixed in position. The stadia constant of the internal-focusing telescope is usually assumed to be zero. This is not strictly true, although the error is negligible in a well-designed instrument at ordinary rod distances. A description of the characteristics of the internal-focusing telescope was given in SURVEYING AND MAPPING.[3]

DOUBLE-IMAGE TACHEOMETERS

The double-image type instrument causes a deviation through a fixed angle of a portion of the rays entering the objective lens. This is accomplished by placing a refracting prism or series of prisms in front of a part of the objective. The angle of deviation is generally such that its tangent is the 1/100th part of the distance. Hence, the multiplier is 100, as for the ordinary stadia. However, the refraction takes place outside the telescope and, unlike the stadia, is independent of the optical dimensions.

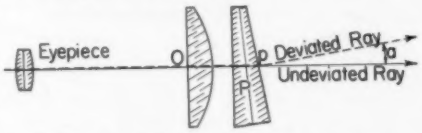


FIGURE. 2.—The deviating wedge prism.

Since any portion of a lens will form a complete image of the object, the effect is an overlapping, confused field of view in the simpler applications of the principle. This may be overcome to some extent in the case of the staff by blacking out all nongraduated areas so that white is superimposed on black. Pointings in azimuth are difficult, and provision is usually made for withdrawing the prism, or at least covering it, when it is desired to use the instrument for other purposes than distance measurement. In any event, the overlapping of the images is objectionable. This has led to designs which divide the field into two separable half-images. These are often referred to as split-field tacheometers. Generally, a provision is made for removing the split-field, leaving a single complete image formed by the part of the objective which is not covered by the deviating prism. The telescope can then function normally, but with reduced illumination.

The use of the deviating wedge with a vertical rod encounters complications not found in the stadia method. The entire deviation is to one side of the line of collimation, hence if the approximation is made that

$$H = ks \cos^2 a,$$

the error is

$$\pm \frac{s \sin 2a}{2},$$

the sign depending on whether a is in elevation or depression and the deviation upward

[2] This point (F in figure 1) is known as the *anallatic point*. A telescope so designed that the anallatic point is at or very near the instrument center is said to be *anallatic*. (Usually spelled *anallactic* in European literature.)

[3] *See* "Stadia Characteristics of the Internal Focusing Telescope," by William Mussetter, SURVEYING AND MAPPING, January–March 1953, Vol. XIII, No. 1, page 15.

or downward. By observing intercepts in the direct and reversed positions of the telescope, the line of sight being directed at the same point on the rod, the same approximation occurs as in the stadia, but here the parallactic angle is doubled.

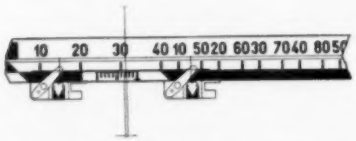


FIGURE 3.—Staff image in double-image tacheometer.

The construction of the staff for a simple deviating prism is affected by the overlapping image and has taken the form shown in figure 3. At any considerable angle of inclination, the scale units of the vernier will vary from those on the staff on which it is superimposed. On the other hand, the use of a horizontal staff presents favorable opportunities for self-reduction in this type instrument. These facts have led the manufacturers of double-image tacheometers to adopt a horizontal staff which is placed normal to the line of sight. The deviating prism is sometimes applied to levels for use with a vertical rod.

The type of staff used with double image tacheometers is shown in figure 4. A vernier, or scale of subdivisions, is fitted to one end and appears as in figure 3 when seen through the telescope. This results in increased accuracy in the readings by removing some of the necessity for estimating fractions. However, due to the necessary coarseness of graduations to be read at a distance and to the large multiplier, the distances are still not precise. Some instruments incorporate an optical micrometer to produce an additional deviation in one of the images so as to bring a main-scale division and a vernier division into coincidence. The amount of distance corresponding to this additional displacement is read from a drum.

From the diagram of the deviating prism (fig. 2) it will be seen that the apex of the parallactic angle, θ, is at the face of the

FIGURE 4.—Staff for use with double-image tacheometer.

prism. Other mountings may place it within the prism. The position of the prism being in front of the objective, a condition analogous to the stadia constant is encountered. The distance in the case of the simple deviating prism shown is measured from the vertex, p, and the internal between this point and the instrument center must be added. However, this may be overcome in various ways. A pair of prisms may be so arranged as to place the apex of the angle at the instrument center as shown in figure 14. Another means for eliminating the constant is the arbitrary displacement of the zero point of the staff vernier to compensate for it. Self-reducing double-image tacheometers do not reduce the length of the constant, and it remains a problem with them.

THE TANGENTIAL PRINCIPLE

The tangential principle is illustrated by figure 5. The base, BC is established perpendicular to the horizontal, OC. Let a equal the angle of inclination, and θ the angle subtended by AB. Then, $AC = D \tan a$, and $BC = D \tan (a+\theta)$.

Therefore,

$$S = BC - AC = D \tan (a+\theta) - D \tan a, \text{ or}$$

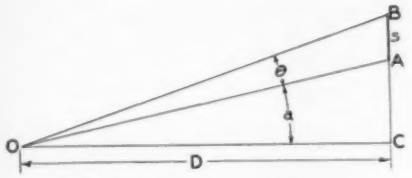


FIGURE 5.—The tangential principle.

$$D = \frac{S}{\tan\ (a+\theta) - \tan\ a} \qquad (2)$$

It will be seen that any instrument capable of measuring an angle at O, could be used as a tangential tacheometer. The evaluation of equation (2) is somewhat laborious, and there is the further complication that when a becomes an angle of depression, all signs in the denominator are reversed.

However, if the angles a and θ are measured in terms of their tangents, and especially if the scale units are so selected as to be simple decimals, the horizontal distance may be obtained directly.

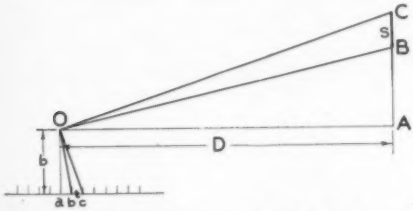


FIGURE 6.—Principle of tangential tacheometer.

In figure 6, O is the horizontal pivot of the telescope, and d is an arm attached to the telescope in such a manner that it revolves with it and is vertical when the line of sight is horizontal. The scale a, b, c is horizontal and graduated in uniform intervals, t, so that $t \div d = .01 = k$. Now, let the telescope be elevated so as to bring the arm, d, from its zero position, a, to some graduation of the scale, b. The line of sight will then cut the vertical rod at B. Next, the index of d is advanced to c, and the rod read at C. The triangles, BOC and bOc, as well as AOB and aOb are similar and

$$\frac{D}{d} = \frac{BC}{bc}$$

If the interval, bc, is one unit of the scale, t, then,

$$D = \frac{ds}{t} = \frac{ds}{.01d} = 100\ S \qquad (3)$$

Also,

$$\frac{h}{ab} = \frac{D}{d}$$

Letting the scale reading of b equal $nt = .01nd$, then

$$h = .01nD \qquad (4)$$

The distance is measured from the instrument center at O, and is free of any instrumental constant.

In spite of its simplicity, the tangential system is no longer manufactured. This is possibly due to the necessity for taking readings in two or more positions of the telescope. Some of the efforts to overcome this disadvantage will be described later.

REDUCTION OF INCLINED MEASUREMENTS

All tacheometers utilizing optical constants measure the distance along the axis of the telescope. When the line of sight is inclined, the measured distance is inclined and must be reduced to its horizontal and vertical components for most surveying purposes.

The necessary reduction depends on whether a vertical or a horizontal staff is used. Figure 7 is a diagram of the case of a vertical rod.

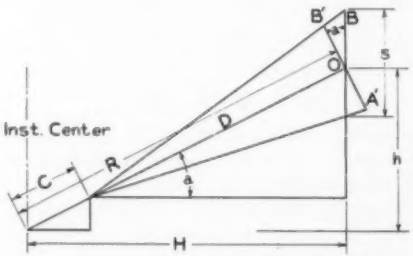


FIGURE 7.—Stadia reduction, vertical rod.

First, the rod intercept must be corrected for the angularity between the rod and the line of sight. The angles at A^1 and B^1 differ from 90° by only one half the parallactic angle, and may properly be considered right

angles. A^1B^1 may therefore be taken as equal to $s \cos a$, the approximation being negligible.[4] A^1B^1 multiplied by the stadia ratio, k, is the inclined distance, D, from the anallatic point, F. The inclined distance, R, to the instrument center is equal to $D + C$, C being the instrument constant. The horizontal distance, H, is equal to $(D + C) \cos a$. Hence the formula for the reduction to the horizontal is,

$$H = (ks \cos a + C) \cos a, \text{ or,}$$
$$H = ks \cos^2 a + C \cos a \quad (5)$$

For simplicity, this is usually approximated to be

$$H = (ks + C) \cos^2 a \quad (6)$$

Modern telescopes with little or no constant, C, permit a further reduction to,

$$H = ks \cos^2 a \quad (7)$$

Similarly, the vertical component of the inclined distance is $R \sin a$, that is,

$$h = (ks \cos a + C) \sin a, \text{ or,}$$
$$h = \frac{1}{2} ks \sin 2a + C \sin a \quad (8)$$

Neglecting the constant, this becomes,

$$h = \frac{1}{2} ks \sin 2a \quad (9)$$

The vertical component can also be stated in terms of the horizontal as,

$$h = H \tan a \quad (10)$$

For the case of the horizontal staff, the first reduction vanishes and the equation for the horizontal distance becomes,

$$H = (ks + C) \cos a \quad (11)$$

and the vertical,

$$h = (ks + C) \sin a \quad (12)$$

The constant, C, is ignored in most cases.

The labor of performing these reductions is considerable, and instrument designers have long been concerned with devices for simplifying or eliminating the reduction.

The tangential instrument was seen to be inherently self-reading to the horizontal, and this type of self-reducing tacheometer was the first offered. The vertical component was still found by a percentage multiplication.

The stadia reduction was first simplified by the application of auxiliary vertical arcs graduated in units corresponding to equations (7) and (9). The units were chosen as simple decimals so that the *correction* for obtaining the horizontal distance and the *difference* in elevation were in terms of percent of the inclined distance. This device is known as the Beaman Arc and is now extensively used, especially with plane table alidades.

Full reduction of the stadia distance can be accomplished by varying the spacing of the lines with the inclination so that $k \cos^2 a$ and $k \frac{1}{2} \sin 2a$ constantly equal the horizontal distance and height difference respectively. The original device for varying the interval was invented by Prof. H. H. Jeffcott in 1912. The lines, or pointers, were attached to levers actuated by cams which were brought into play by rotating the telescope. A more rapid change is required for the vertical than for the horizontal reduction. As a consequence, at large angles of inclination, the vertical pointer passed out of the normal eyepiece field, requiring that the ocular be mounted in a slide so as to follow the pointer. This apparatus is no longer manufactured.

The next step was the so-called "curve tacheometers" in which the stadia lines are in the form of curves engraved on glass reticles. The curves are caused to run across the field of view by tilting the telescope. The radial intervals between the lines are in accord with equations (7) and (9). Rotation of the telescope positions the curves so that the horizontal and vertical components of the range are always ks. However, different values of k are used for the vertical reduction curves. Several forms of curve tacheometers are now produced, and they are very suitable for work where speed is desired rather than the highest accuracy.

Double-image tacheometers using hori-

[4] Precisely, $A^1B^1 = s \left[\frac{\cos (a+m) + \cos (a-m)}{\cos m} \right]$, in which m equals one half the parallactic angle, or about 17′ for the ratio, 100: 1. In the rather extreme case of $a = 30°$, this does not differ in the 5th place of logarithms from $s \cos a$.

zontal staffs reduce in accord with equations (11) and (12), the constant being ignored. This is achieved through the properties of a rotating wedge prism, as seen in figure 8.

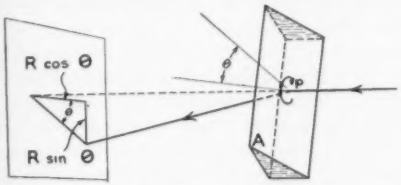


FIGURE 8.—The rotating wedge.

A light ray striking the face of a prism whose sharp edge is placed vertically will be refracted horizontally. If the prism is rotated as shown through the angle, θ, from the horizontal, the ray is refracted in a plane perpendicular to the apex, A, through the distance R. This distance can be resolved into its horizontal and vertical components, $R \cos \theta$ and $R \sin \theta$, respectively. Now, if two prisms are placed one in front of the other and initially with their sharp edges to the same side and vertical, the ray will be deviated horizontally by the refraction of both prisms. If the two prisms are rotated at the same rate and in opposite directions, the horizontal component of the deviation will vary with $\cos \theta$, while the vertical components of the two prisms will cancel each other. The rotation is imparted by, and is equal to, the inclination of the telescope. Hence, the staff intercept is reduced by $\cos a$, and horizontal distances are read directly.

If the prisms are rotated together through 90° from their original position, the horizontal deviation is zero. An equal and opposite rotation from this position by the tilting of the telescope will cause the horizontal component to vary with $\sin a$, and vertical differences can be read directly from the horizontal staff. This apparatus is known as the diasporameter and was devised by Boscovic.

EXAMPLES OF REDUCING STADIA INSTRUMENTS

The Beaman Stadia Arc was patented in America in 1906 and is one of the best known. It consists of two auxiliary graduations placed on the vertical circle or on a special arc. The scale for horizontal reduction is graduated into angles whose function, $1\text{-}\cos^2 a$ successively equals 0.01, 0.02, 0.03, etc. The scale for vertical reduction is similarly graduated to the function, $\frac{1}{2} \sin 2a$. The multiplication therefore becomes one of percent.

The usual procedure for utilizing the Beaman arc is to multiply the rod intercept by 100 and add or ignore the constant. The result is then multiplied by the percentage indicated on the horizontal reduction scale. The product is subtracted from the inclined distance to obtain the horizontal range. The vertical difference is found by multiplying the inclined distance by the percentage read from the vertical scale, whose position corresponding to a level sight is given the number, 50, in order to avoid negative readings.

The scales are non-linear, hence no simple vernier or micrometer can be used to subdivide them, and the precision is limited by the ability to read fractions of one percent by estimation. If a gradienter is applied to the vertical motion, it may be used for measuring the fraction by turning back to an even percentage on the scale and noting the divisions on the gradienter.

The Watts Microptic alidade employs a Beaman scale engraved on the vertical circle, and read, with the regular scale, through a microscope.

The Beaman Arc is not strictly a self-reduction device, but it simplifies the multiplication and dispenses with tables of functions.

Variable spacing of the stadia lines.

The first attempt at varying the stadia ratio by Prof. Jeffcott was soon superseded by glass scales bearing stadia lines engraved as curves representing equations (7) and (9). These scales, or their images, were caused to pass across the field of view by the rotation of the telescope about its horizontal axis, the proper interval being positioned at any given inclination. Both horizontal and vertical reductions are made directly by this method.

The Hammer-Fennel tacheometer is of this class. It follows the original design of Prof. E. Hammer. The lines are engraved on a glass sector carried in a mount rigidly attached to the instrument standard. A prismatic microscope system causes a partial image of the sector to be formed on the surface of a prismatic reticle covering half the field of view, the dividing line being vertical and in the line of collimation according to the inclination of the telescope, the image presented is of the portion of the sector so that the interval between the ends of the lines where they appear to run off this dividing line determine rod intercepts which, when multiplied by the proper constants, give the horizontal and vertical distances from the instrument center. The multipliers are 100 for the horizontal distance, and 10 and 20 for the vertical, in present models.

FIGURE 9.—The Hammer-Fennel sector.

Figures 9 and 10 illustrate the design of the glass sector and the appearance of the field of view in the inclined telescope.

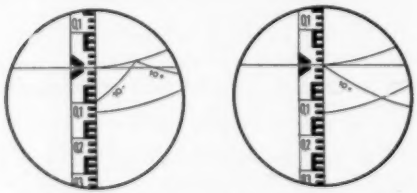


FIGURE 10.—Rod reading, Hammer-Fennel tacheometer.

In figure 9, the line designated *N* is the null, or zero, line and is a circle concentric with the apparent rotation of the sector. The curve, *E*, is so drawn that the radial interval between it and *N* varies with $\cos^2 a$, the curves being symmetrical on either side of the telescope's horizontal position. The cusped curves, *D* and *d*, are for reading the rod intercept corresponding to the elevation difference. The short curve, *D*, is read for inclinations up to 14°, the intercept being multiplied by 10 to obtain the difference in elevation. For greater inclinations, up to a limit of 47°, curve *d*, is used with a multiple of 20. The multipliers and plus and minus signs to indicate elevation or depression are engraved near the lines and appear in the field. It will be noted that there are no extra moving parts in this instrument.

In addition to the images of the curves, the reticle has a single horizontal line corresponding to the usual upper stadia line. When the sector is properly adjusted, the null line will always appear tangent to this fixed line. Vertical differences apply to the rod reading cut by these two lines.

In use, the rod is sighted and its graduated edge brought to coincidence with the vertical dividing line of the field. The null line is then set on a unit graduation and the horizontal and vertical intercepts read from the appropriate curves as shown in figure 10. The special rod furnished with the Hammer-Fennel apparatus has two scales arranged for an inverting telescope. The first is graduated upward from the bottom to 1.4 meters, the second from this point as zero again to 1.4 meters. The scales are painted different colors and a target at their junction facilitates setting the zero line.

The Kern DKR tacheometer employs curves engraved on a revolving glass circle placed in the focal plane of the telescope. This circle is placed in a housing attached to the telescope and so positioned and pivoted that the curves are placed directly in the field of view and appear in the same plane with the lines on a conventional glass reticle. A shaft and gearing cause the circle to rotate with the inclination of the telescope so positioning the curves that they intercept readings corresponding to the horizontal and vertical components of the distance.

The appearance of the field, with and without the rod, is shown in figure 11. Instead of using a circular base curve, the two curves are symmetrical about the center of the field so that each has half the pitch

of a single curve used with a base line. There are three sets of elevation curves with multiplication factors of 20, 50 and 100. These are used for slopes up to 12°, 27° and 40° respectively. The elevation curves are arranged to always lie between the horizontal curves and, to avoid confusion, are broken before their intersection at the point where the inclination of the sight is zero. For very small slopes, the elevation difference is more accurately obtained by leveling. Should the inclination exceed 40°, the rod is read by the conventional stadia lines on the reticle, and reduced mathematically.

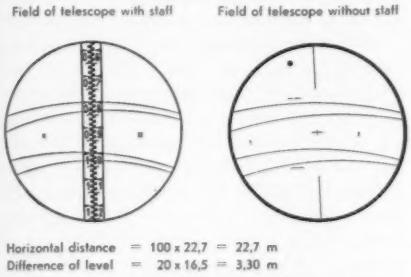

Field of telescope with staff
Field of telescope without staff
Horizontal distance = 100 x 22,7 = 22,7 m
Difference of level = 20 x 16,5 = 3,30 m

FIGURE 11.—Field of view, Kern DKR

In order to take a measurement, one of the two outer lines is placed on a unit graduation, and the intercept is read from this mark to the other outer line. This multiplied by 100 gives the horizontal distance to the rod. One of the inner curves may then be brought to a graduation, and the intercept of the inner curves is read. The proper multiplier is indicated by a series of ticks etched between the lines: two parallel ticks indicate a factor of 20; 5 ticks, 50; and a single tick, 100. The elevation applies to the rod reading indicated by the cross at the center of the stationary reticle. The rod must be brought closely to the center of the field, although the gentle slope of the curves minimizes the error caused by an off-center or waving rod. The field of view is clear and normal except for the introduction of the stadia-reduction curves.

The Kern alidade RK is similar to the above with the exception that the image is erect. The Kern tacheometers can be used with any type stadia or leveling rod. A stadia rod with quick-reading block centimeter scale is recommended.

The Wild RDS is a curve tacheometer in which the stadia lines are placed on a vertically-mounted glass circle concentric with the telescope's horizontal axis and occupying a housing on the right-hand side of the instrument. By means of a planetary gear train, the circle is caused to rotate at a speed of three times that of the telescope about its axis. This rotation is opposite in direction to that of the telescope, and the effect is that a given point on the circle passes through the field of view at a rate four times that of one on a stationary sector. Hence, the entire circumference is taken up by the curves corresponding to a tilt of the axis from plus 45° to minus 45°. This reduces their slopes in a 1:4 ratio for the same multiplication constants, resulting in a maximum slope of 15′ for the horizontal distance curve. The vertical-component curves incline up to 6°.

So seen in the normal position of the telescope, the lower line is a circle or zero line. Of the two other lines, visible, the extreme upper is always the horizontal-distance curve and has a constant multiplication factor of 100. The intercept for finding the elevation difference is read between the lower, zero, line and central curve. This curve is broken into four sections applying to inclinations from 0° to 5°, 4° to 10°, 9° to 23° and 22° to 44°. The multiplication constants are 10, 20, 50 and 100 respectively. The height lines are marked with the figures 0.1, 0.2, ½ and 1 in such manner that the figure applying to the curve in use is always visible. These are also shown as plus for elevation and minus for depression angles. A view of the field is shown in figure 12. The entire field is open. In addition to the stadia curves, there is a fixed vertical thread for directional pointings and a short cross line indicating the center.

The image formed by the objective is diverted by a prism and brought to focus on the stadia-diagram circle. A combined image of the rod and lines is transferred to the normal glass reticle by means of a microscope system including directional prisms.

In the process, the rod image is rotated and appears erect in the eyepiece.

Any rod with suitable graduations and upright numbers can be used with the RDS. A stadia rod with block centimeters in quick-reading groups is recommended. In practice, the rod is brought into the center of the field and the zero circle line placed on a unit graduation approximating the height of the instrument. The intercepts are then read from the other curves where they

FIGURE 12.—Field of view, Wild RDS.

cross the vertical thread. Centimeters are read as meters directly for the horizontal distance. The vertical intercept in centimeters, multiplied by the applicable constant, is the vertical interval in meters between the instrument and the rod reading of the zero line. Feet and hundredths are treated similarly. Due to the slight inclination of the lines, the readings are little affected by a wavering or slightly off-center rod.

The Zeiss Dahlta was introduced by the Jena works, but is apparently no longer manufactured by them. An almost identical design is made by Filotecnica Salmoiraghi.

In this design, the stadia curves are etched directly on the glass vertical circle, which is rigidly attached to the standard instead of to the telescope. The optical path of the telescope is broken by means of prisms and passed through the vertical limb, the focal plane lying in the plane of the graduations. The eyepiece is offset to the left, on the side of the instrument. The graduations serve as the reticle, and reimagining systems are not necessary. The zero reference line lies near the bottom of the field. The upper curve forming the horizontal stadia interval is similar to the design of Prof. Hammer. The vertical-reduction lines are relatively short segments of overlapping curves with different multiplication factors, which come into view when needed as the telescope is inclined. The vertical-circle graduations appear adjacent to the zero stadia line. The field is open and normal. Readings are taken in the same manner as for the foregoing instruments.

The self-reducing mechanism of the curve tacheometers does not interfere with normal use of the instruments. In some, the regular vertical circle is omitted. The horizontal circles are read by some form of scale microscope to a precision commensurate with the use of the instrument. Generally, the distances are read with the telescope in its normal position only. Those tacheometers with continuously graduated and revolving diagram circles can be used in the reversed position. The signs applying to the vertical-reduction curves must then be reversed.

The curve tacheometers are very rapid and convenient in use. Their accuracy is about the same as the ordinary stadia instrument. Because of the problems of maintenance of adjustments, focal planes and magnification, a high class of workmanship and rugged design are required. The cost is approximately twice that of a standard stadia tacheometer.

DOUBLE-IMAGE TACHEOMETERS

The simplest device for creating two displaced images is the distance wedge. This is usually made in the form of an attachment to be placed in front of the objective lens of a standard instrument. The wedge consists of a single achromatic prism or an achromatic pair separated slightly to provide an adjustment. The optical wedge is intended for use with a horizontal staff, which often must be mated with the instrument.

The wedge is mounted horizontally so as to cover the central approximate half of the lens. So manufactured, it produces a hori-

zontal refraction of the rays passing through it equal to $\tan^{-1} 0.01$. The view through the telescope with the wedge in place shows two confused images, one of which is given linear displacement to the left, with respect to the other, equal to 1/100th part of the distance.

The staff usually furnished is about 1.6 meters long, the main scale being graduated in centimeters. On the right-hand end of the staff is a wernier scale, its lower edge coinciding with the upper edge of the main scale. The vernier is 19 cm. in length and divided into 20 parts. Hence the minimum reading is to 0.5 mm., corresponding to a staff distance of 5 cm. The ungraduated parts of the staff are painted black to minimize the interference of the merged images. The staff is erected over the station point, adjusted to instrument height, leveled, and directed normal to the line of sight by means of a sighting device. The axis of the distance wedge must be made parallel to the staff in order that the vernier image will be in contact with that of the main scale.

The image formed in the telescope is shown in figure 3, the vernier index being displaced along the scale a distance equal to 1/100th of the distance to the staff. Meters of distance are read directly from the centimeter scale, and fractions by means of the vernier to 5 cm. The fraction can be read to 2½ cm. by estimation, and for short distances, even to 1 cm. Maximum and minimum sights are limited by the standard staff to about 160 m., and 20 m. Some staffs may be given an extension for reading greater distance, up to 236 m. Also, auxiliary marks may be used to obtain short readings when the vernier is not in full contact with the scale. Sometimes, a special small staff is provided for attachment above the regular board.

The constant of the prism, as shown in figure 2, can be corrected by an arbitrary displacement of the staff vernier with respect to the scale, or the constant may be wholly or partially compensated by displacing the staff from its plumb point. Since it would be quite difficult to make a prism with exactly 0.01 deviation, most manufacturers graduate the rod to agree with the actual deviation. Hence, with most simple wedges, a given rod may be used with only a single instrument.

For the purpose of reading angles, the confused field can be avoided by swinging the prism away from the lens on a hinge, or it may simply be covered by a finger. Covering the prism cuts out the displaced image and leaves the one formed by the outer zones of the objective.

Accuracies of 2 cm. in 100 m. are claimed by the makers. The ranges obtained by the distance wedge are inclined and must be reduced by equations (11) and (12).

The next step in refining the double-image device is the application of a parallel-plate micrometer in front of the deviating wedge for measuring the remaining fraction of a vernier division. By rotating the parallel-plate about a vertical axis, the angle of deviation is altered slightly so that the vernier and main scale graduations are brought into coincidence. The fraction of a division is read on the drum of the micrometer. The reading is then free of estimation to 1 mm. of rod distance.

FIGURE 13.—Vernier brought to coincidence by micrometer.

The Wild Telemeter is an attachment of this type. In addition to the micrometer, there is a means for adjusting the prism, enabling the instrument to be calibrated to a standard staff. This eliminates a disadvantage of the simple wedge. An adjustment for "run" is also provided in the micrometer by altering the throw of the linkage.

The Kern DM-M apparatus incorporates a plane-parallel micrometer with the distance wedge. The staff for this instrument is graduated in 2 cm. units, premitting heavier divisions and facilitating readings at greater distances. A view of this staff, as seen in coincidence, is shown by figure 13. The second vernier is offset 30 cm., and all measurements made with it must have 30 m. added to them. This vernier is used for

longer sights when the regular one passes off the scale.

The above devices measure a slope distance. The images overlap and azimuth pointings are made either by ignoring the displaced image, or by covering the prism.

Kern offers an attachment which reduces the distance to the horizontal, known as the DR stadia prism. The deviating wedge is replaced by a pair of Boscovic rotating prisms which are made to alter the stadia ratio in accord with cos a. However, these prisms are not geared to the telescope inclination as in more elaborate instruments, but are controlled by means of a manually operated knob and a level bubble. The telescope is first sighted at the staff, the knob is turned until the bubble is centered, and the horizontal distance read directly from the staff. Vertical differences must be computed from the horizontal distance and the angle read on the vertical circle. As with the non-reducing devices, the image is confused, and the accuracy is the same. This is claimed to be in the range of 1 to 2 cm., depending on the distance. No doubt, this presumes good visibility.

The foregoing attachments have the advantage that they are relatively cheap and may be applied to a standard theodolite and removed when not needed. They must be adjusted about the telescope axis so as to make the deviation truly horizontal. In case it is desired to use the telescope in the reversed position, the attachment must be rotated 180°. A counterweight must, of course, be applied to the eye end of the telescope.

The optical wedge makes certain demands on the telescope. The two images must be seen in sharp focus and without parallax. The objective must be corrected so as to form a proper image by its outer zones.

The Zeiss Lodis is a simple type of double image instrument, noteworthy in that it is used with a vertical rod. It is especially designed for topography by the rectangular-coordinate method and such works as cross-sectioning, etc. A section through the telescope is shown in figure 14.

Two refracting prisms are placed in front of the objective and cover half the lens; that is, they intercept all rays entering the telescope to one side of a vertical line through the axis. The combined effect of the prisms is to deflect vertically those rays passing through them by an angle, $\tan^{-1} 0.05$, this being the fixed parallactic angle. The overlapping of the images is avoided by means of a vertical septum through the telescope axis, and a weak bi-prism near the reticule.

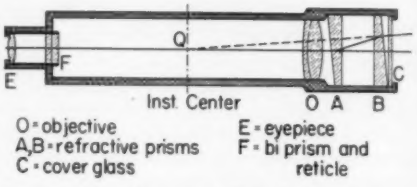


FIGURE 14.—Diagram of Zeiss Lodis telescope.

The rod used with the Lodis has a single graduation, but is identically numbered along both sides of the face. On viewing the rod through the telescope, it appears as though split longitudinally with one half displaced vertically with respect to the other by an amount equal to 1/20th of the distance. The rod is graduated in half-centimeter units and numbered in half-decimeters; that is 1/20 m. Hence, the difference in the scale readings of the two half-images of the rod in half-decimeter units gives the rod distance in meters. The instrument is a level with no horizontal axis, hence only horizontal distances are measured.

The vertex of the parallactic angle is fixed by the relative strength and positions of the two prisms. By proper design, it can be placed truly at the instrument center, and the Lodis is so constructed. If, as in figure 14, Q is the center, D, the distance from Q along the axis to the intersection with the ray refracted by the first prism; and r_1, and r_2 the angles of deviation of the two prisms, respectively; then the apex of the parallactic angle will be at Q when $r_2 d = D\ (r_1 - r_2)$. The quantity $(r_1 - r_2)$ is the deviation of the combination. The above proposition is illustrated graphically in figure 14 by extending the external refracted ray

through both prisms to its intersection with the axial ray Q.

FIGURE 15.—View through Lodis.

The Lodis is intended for short sights in level areas, hence the large deviation angle and fine rod graduation. Provision is made for rotating the prism unit through 180° about the telescope axis. When the prisms cover the left half of the lens, the deviation is upward; when the right, downward. This permits considerable flexibility over rough ground with the non-tilting telescope. A modified design, called the "Tiltlodis", is provided with a limited range of inclination. Reduction of distance to the horizontal is accomplished through a Beaman arc arrangement. Difference in height is obtained by reading the inclination from a vertical arc, and tables.

The most elaborate tacheometers of the double-image type follow the original design of Dr. Bosshardt. His design was first produced by Zeiss under the name "Redta". This instrument employs a horizontal staff as described under the distance wedges. Fractional vernier units are read from an optical micrometer, and the inclined distance is automatically reduced to the horizontal. Height differences are reduced by means of a scale of tangents read under magnification. The Redta is a true split-field instrument, that is, its two half-fields are distinct and divided by a fine horizontal line. When desired for measuring angles, the divided image is replaced by a full undeviated image formed by the upper half of the objective by operating a ring immediately in front of the eyepiece.

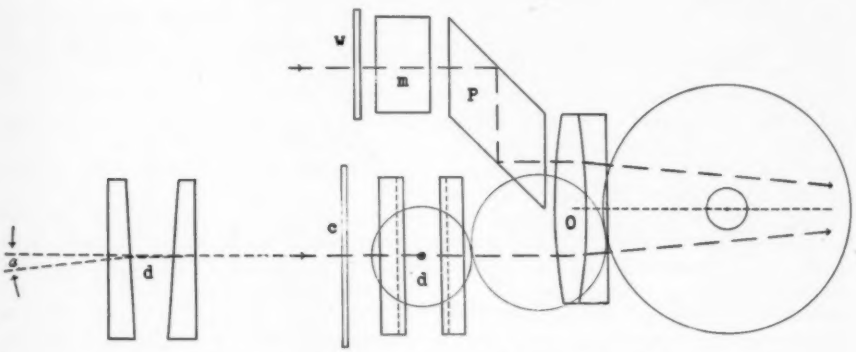


FIGURE 16.—Diagram of Bosshardt-Zeiss apparatus.

Figure 16 represents a simplified diagram of the optical system of this instrument. Light is admitted to the single objective through two passages. That for the undeviated field enters by a window, w, and passes through a rhomboid prism to the upper half of the lens. The purpose of this prism is merely to offset the rays about solid parts of the instrument, and not to deviate them. Light entering the other half of the objective must pass through the diasporam-

eter, *d*. This is composed of two identical achromatic wedges so mounted that, by tilting the telescope, they are caused to revolve equally in opposite directions and through angles equal to the inclination of the line of sight. When the telescope is horizontal, the thicker edges of the prisms lie adjacent and the maximum deviation is produced in the horizontal direction. This is designed to be $\tan^{-1} 0.01$. As the telescope is inclined, the rotation varies this deviation in ratio to cos *a*. The vertical refraction components, equal to $k \sin a$, are cancelled by the equal and opposite rotation of the wedges. When the telescope has tilted to the vertical position, each of the wedges has turned through 90° and the thick edge of one lies opposite the thin edge of the other. All deviation is therefore cancelled out. On turning the telescope to the horizontal reversed position, the wedges again lie in the position of maximum deviation. Thus, they continuously solve equation (11).

The view of the rod is similar to that in the case of the distance wedge, except that there is no overlapping of the images. The split field is accomplished by a bi-prismatic surface on the forward erector lens. The apex is horizontal, hence the rays are compressed vertically. This causes the rays which cross the axis to be thrown back across it to the rear of the lens at a greater than normal angle. An oblong stop with its smaller dimension vertical intercepts and eliminates these outwardly-thrown rays, permitting only those rays entering the upper half of the objective to form an image in the upper half of the focal plane. Conversely, only the lower half of the objective forms the lower half of the image. The split-field is removed by removing the stop and inserting a diaphragm to remove the rays entering through the deviating mechanism. The Bosshardt-Zeiss telescope is erecting. Obviously, the magnification differs in the vertical and horizontal planes, but this has no noticeable effect on the image.

Various length staffs are provided for different lengths of sight. Two verniers are applied, one at the extreme end, and the other for shorter distances, 0.6 m inward. The divisions are to 2 cm., numbered at each decimeter. Two figures are applied, one large and black, the other smaller and red, for use with the different verniers. The black numbers imply a figure 1 preceding, so that division 2 is read 12, etc. The value of 9 rod units is divided into 10 vernier units, the minimum reading being 2 mm.

The minimum vernier unit of 2 mm. provides a direct reading to 20 cm. only. To overcome this and eliminate the necessity for estimation, a plane-parallel-plate micrometer, (*m*, figure 16), is placed in front of the rhomboid prism. This plate is capable of displacing the rays horizontally through a range of 2 mm. A vernier graduation can be brought into exact coincidence with one on the main scale, and the movement necessary to do so read from the micrometer drum. The drum is divided into 20 divisions equivalent to centimeters of distance. Millimeters may be estimated, should anyone care to do so.

Aside from the optical system, the Bosshardt tacheometer follows the regular design of theodolite. Both circles are read through a scale microscope placed alongside the telescope eyepiece. In addition to its regular scale, the vertical circle has a scale of tangents in units of 0.002. The reading from this tangent scale is multiplied by the horizontal distance to obtain the elevation difference. This is the only operation requiring computation and is, of course, a decimal multiplication.

The apex of the parallactic angle is formed midway between the two rotating prisms. This causes the equivalent of a stadia constant, which can be eliminated from the inclined distance by displacing the vernier zero points. Since the instrument is self-reducing this introduces a slight error in that the constant is not reduced. As a refinement, an auxiliary scale is fixed to the side of the vertical-circle housing from which the small correction can be read.

As with other optically-deviating instruments, the exact parallactic angle is difficult to obtain, and a weak wedge prism, (*c*, figure 16) is placed in front of the rotating prisms to provide a calibration adjustment. This prism can be rotated a small amount for the purpose of adding its horizontal

component to the refraction caused by the rotating wedges, and the sum made exactly equivalent to 0.01. Any personal equation of the operator may likewise be eliminated. The staffs are therefore in true units and are interchangeable.

The vertical line in the undeviated part of the field may be used for azimuth pointings, or by turning the ring controlling the stop, the single, full field may be obtained. Vertical pointings may be made with the full field as by a conventional instrument, or by bisecting the target with the division line between the half-fields.

The Redta is fairly large and heavy, (about 30 lbs., with tripod) and quite costly. New instruments are not available at present.

The makers claim an accuracy of from 2 to 3 cm. at 200 meters. This probably can be realized in a steady atmosphere.

The Wild RDH is also designed on the Bosshardt principle, but differs from the Zeiss model in several details. Figure 17 is a cross section of the RDS telescope.

fected by rotating a weak wedge placed in front of the Boscovic unit.

The plane-parallel micrometer prism is eliminated by mounting the rhomboidal transfer prism on a vertical axis, thus combining with it the function of the micrometer prism. The actuating screw is mounted on top of the telescope and carries a scale on a drum which is viewed from the eye-end through a fixed magnifying glass.

The telescope is inverting and of split-field design. The division of images is attained by means of a bi-prism near the focal plane, and a stop as previously described. The stop is controlled by a ring surrounding the eyepiece, and when removed, the image is full and normal.

The staff is similar to others designed for use with inverting, double-image telescopes. The main graduations are in 2 cm. units, and the vernier reads to 2 mm. When the two scale marks are brought to coincidence, the micrometer can be read directly to 1 cm. of distance.

The Wild RDH can be used as a conven-

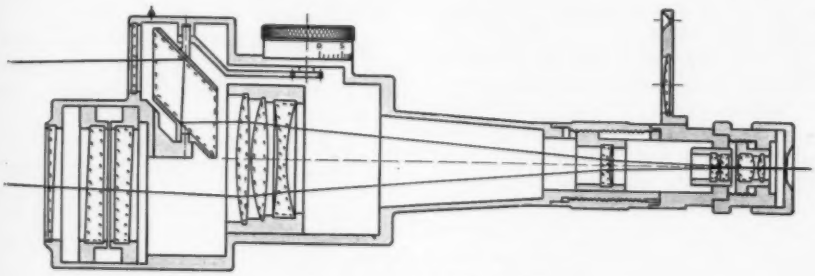


FIGURE 17.—Section through Wild RDH telescope.

A feature of this instrument is that the rotating prisms are so arranged that they can be turned as a unit through 90°. They are then in position to vary the horizontal deviation in proportion to the sine of the inclination. The difference in elevation between the instrument and staff can thus be read directly by the same scales as employed in the horizontal measurement. The prism unit is placed in the desired position by turning a knob near the top of the instrument on the right hand side. Calibration is effected by rotating a weak wedge placed in front of the Boscovic unit.

tional theodolite. No tangent scale is needed for vertical reduction. The normal horizontal- and vertical-scale microscopes appear in the circle microscope placed to the left of the telescope eyepiece. Since the staffs are designed for deviation in one direction only, measurements are taken with the telescope in normal position.

The weight of the RDH with tripod is about 28 lbs. The cost is about double that of the curve tacheometers.

The Kern DK-RT is built on the design

of the DK2 series of theodolites and incorporates the Bosshardt principle. A diagrammatic cross section of its telescope is shown in figure 18.

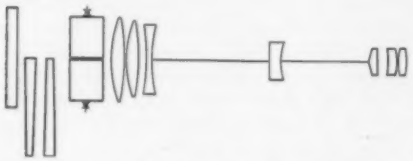


FIGURE 18.—Diagram of Kern DK-RT telescope.

The split-field is provided by a horizontal septum inside the telescope which prevents rays to the rear of the objective from crossing the axis. A converging by-prism, with stop, renders the diaphragm invisible. By rotating a ring located just ahead of the eyepiece, the split field is removed and the instrument can be used as a conventional theodolite. A regular reticle with stadia lines is provided for use in the single-field position. The magnifier for reading the split-field micrometer drum is located on the shifting ring and becomes inoperative in the single-field position, positively indicating the condition of the optical system.

The circumference of the rotating-prism pair extends only to the center of the objective, resulting in a segmental coverage and apparently some loss of light transmission. This arrangement eliminates the transfer prism, hence the light paths of the two rays are identical except for glass equivalent, and the two fields are simultaneously in sharp focus on short sights.

Two thick parallel - plate - micrometer prisms pivoted on a vertical axis each cover one half of the objective. These are rotated equally in opposite directions by the graduated knob to provide coincidence in the staff graduations. The micrometer scale is in centimeters of distance.

The staff furnished with the DK-RT differs in graduation from those previously described. The verniers are replaced by two short index scales divided in centimeters. The main scale is graduated in 2 cm. units. The use of two opposed parallel plates permits the micrometer to bring two of the index marks into coincidence with the main scale graduation in any circumstance. A view of the staff with the marks in coincidence is shown in figure 19.

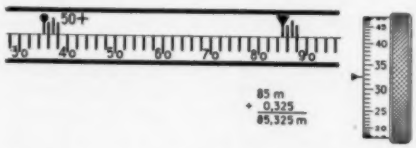


FIGURE 19.—Staff of Kern DK-RT in coincidence.

The DK-RT is relatively light and compact. It weighs approximately 23 lbs., with tripod. The standard staff is 1.7 m. long, and with an extension may be used for measurements from 2 to 236 m.

Other designs include those of Uhink and Hugershoff. The author has not had opportunity to examine either. They appear to have been experimental models only.

Uhink employed a pair of rocking trapezoidal prisms, each covering one half of the objective, to produce the parallactic angle and the additional motion to bring coincidence to the staff graduations. The prisms combine the functions of the distance wedge and micrometer. This instrument is not self-reducing.

The Hugershoff model secures automatic reduction of both horizontal and height differences, using a vertical rod, in accord with equations (7) and (9). It does this by the presentation of sections of the images formed by three separate telescopes in a single field of view. The central image is undeviated. The others are refracted by rotating prisms. The left hand objective is covered by a rotating pair, which, when the telescope is level, lie with their thick edges horizontal and in conjunction, providing the maximum deviation, $k = 0.01$. One wedge is fixed; the other identical prism rotates at twice the rate of inclination, that is, through $2a$. The total deviation is thus,

$$\frac{1}{2}k + \frac{1}{2}k \cos 2a = k\frac{(1+\cos 2a)}{2}.$$

Substituting $\cos 2a = 2\cos^2 a - 1$, this becomes, $k \cos^2 a$.

The third objective is covered by a single wedge of strength ½k which also rotates through 2*a*. In the level position, the thick edge is vertical. The deviation produced is equal to ½k sin 2*a*, which agrees with equation (9). The range of inclination is limited to 45° above and below horizontal.

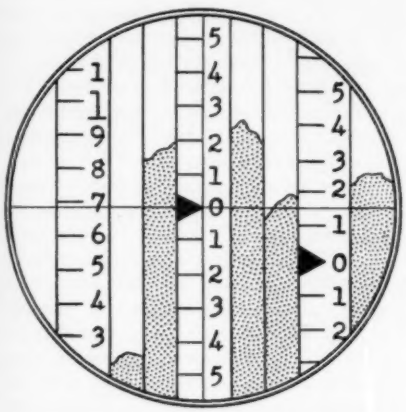


FIGURE 20.—Field of Hugershoff-Heyde tacheometer.

The zero of the rod is placed at average instrument height. The scale is graduated upward and downward from the zero. Figure 20 shows the field of view. A common cross-hair is set on the zero of the central image. The horizontal distance is read at the hair from the left-hand image, the height difference from the right-hand image. Fractional units must be estimated, and the instrument constant cannot be eliminated.

The Tangential Tacheometers

There is no known availability of tangential tacheometers at the present time. The following descriptions are presented chiefly for their historical interest.

Eckhold's Omnimeter was patented in 1866. It incorporated a microscope fitted to the telescope with its axis accurately at right angles with the line of sight, and passing through the horizontal axis. A uniformly graduated scale on the horizontal plate was read through the microscope. The scale units were usually 0.02 inch. Fractions were read by imparting a small-longitudinal motion to the scale by means of a micrometer screw having 50 threads to the inch. This motion was used to bring a scale division into the line of sight of the microscope, the fraction being read from a drum on the screw. The scale zero was set to the horizontal position of the telescope.

Customarily the scale was read at two pointings on the staff an even number of units apart, preferably 10 feet. Referring to figure 6, it is seen that the intercept times the instrument constant divided by the interval between the readings of the scale, stated in divisions, is equal to the horizontal distance. In this case, the constant is equal to the perpendicular distance, *d*, divided by the length of a scale division.

The height difference was obtained either from the tangent of the vertical angle or by the formula,

$$h = \frac{sn_1}{(n_2 - n_1)}$$

in which s is the intercept, and n_1 and n_2 are the scale readings at b and c respectively. It was intended that the constant should be a round number, but this was difficult to maintain and frequent calibrations were in order.

In later models of the Omnimeter, the microscope eyepiece was placed alongside the telescope eyepiece. Another modification, known as the Bell-Elliot tacheometer had the scale graduated in natural tangents of the angles of inclination.

The Kern Contact Tacheometer was a somewhat similar instrument. Instead of reading a scale for a fixed intercept, this instrument established inclination angles whose tangents varied in a linear scale. The rod was read at two or more of these inclinations, and the intercept multiplied by the constant to determine the horizontal distance. Figure 6 will also serve to demonstrate the Contact Tacheometer.

The instrument is fitted with a ball-crank lever pivoting about the horizontal axis of the telescope. When it is desired to use the device, one terminal of the lever is secured

to the telescope, causing the lever to rotate with it. The other arm of the lever is exactly at the right angles to the line of sight; that is, vertical when the telescope is horizontal. This arm engages a slide which runs in a horizontal guide, by means of a ball and slot, so that on tilting the telescope, the tangent of the angle of tilt is imparted to the slide. Conversely, equal linear movements of the slide impart increments to the angle of inclination such that its tangent changes by equal amounts. The unit of movement and length of the level arm are so adjusted that the successive tangents differ by 0.01.

The slide can be clamped at will to its guide and the guide in turn can be given a longitudinal motion by a slow-motion screw. In addition, an eccentric cam is so arranged as to advance the guide bar in three equal steps when a knob is turned. The steps are fixed by click-stops. A linear scale is mounted above the guide bar, indicating angles of inclination whose tangents change in steps of 0.01. Hence, it amounts to a percentage scale. Fractions of a scale unit are read by means of a vernier to 1/20th unit, or 0.05 percent.

In order to take a measurement, the slide is unclamped and the telescope directed at the rod. The slide is then clamped and contact made with the rod at some unit graduation by means of the slow-motion screw actuating the guide bar. The guide is then advanced by the cam mechanism one notch, and the rod is read. The rod interval between the two sights multiplied by 100 equals the horizontal distance. Customarily, the slide is advanced another notch and the total intercept multiplied by 50. Meanwhile, the tangent scale is read by the vernier at the mid-point. This reading, taken as percent, multiplied by the horizontal distance, gives the elevation difference to the mid-point reading on the rod. It will be noted that the angles produced have their vertices at the telescope axis; hence no form of stadia constant is introduced.

Both the above tangential tacheometers required two or more pointings on the rod. A design by the Hungarian, Szepessy, made for a time by Watts, overcame this disadvantage by a system analogous to the curve tacheometers.

The Szepessy instrument utilizes a glass circle graduated on its edge by a scale of tangents. The circle is attached to the verticle-circle housing so as not to rotate, and in a position concentric with the telescope axis. Light passing through the scale is transferred by a microscope mounted on the telescope to form an image of the graduations in one side of the field of view. The tangent scale is in units of half-hundredths, figured at the hundredths. Therefore the figures represent percent.

To take a reading, the telescope is tilted to bring a numbered scale graduation to coincidence with the horizontal cross-hair. The rod intercept between any two scale graduations multiplied by the number of divisions between them, taken as percent, gives the horizontal distance. The figure applying to the scale line lying on the cross hair, also taken in percent, multiplied by the horizontal distance yields the vertical interval to the rod reading at the cross-hair.

Relative Merits of the Different Types

The three types represent specialized instruments designed for definite functions. The stadia type has the advantage of simplicity and speed. A simple vertical rod, usually hand-held, is generally sufficient. In case of interfering foliage, it is often possible to shift the sight vertically to secure a reading without moving the rod. In contrast with the stadia, the mechanical tangential instruments suffered from the necessity of a double manipulation. This probably accounts for their abandonment. While Szepessy's design overcame this drawback, its adjustments were difficult to maintain, and theoretically the chances were that all rod readings required estimation of fractions. One estimation could be eliminated by a slight movement of one mark to a rod division with negligible error.

There is the danger in all instruments used with a vertical rod of encountering a difference in the refraction of the two rays. When working close to the ground, the lower ray is subject to greater bending than

the upper, causing an error in the intercept. This error is systematic in sign but variable in amount. It also varies with the square of the distance.

The double-image tacheometers utilizing the horizontal staff, eliminate or minimize the refraction error. The displacement of images permits the staff to be designed with a vernier device, and in case of the instruments furnished with a micrometer, eliminates estimation of fractions of rod units.[5] The precision gained by coincidence of marks may largely be lost in an unsteady atmosphere.

There is a serious disadvantage in the use of horizontal staffs caused by the necessary centering, plumbing, leveling and directing, and their instability in the wind. Also, the clear path to the staff must be wider, and if a critical part of the scale is obstructed, little can be done except move the staff to a new position. The length of sight is, of course, limited by the length of staff. With the longest scales, this is about 250 meters. While this is above average for good stadia work, it precludes the use of an occasional long sight to get out of a pocket.

The double-image attachments have a field where there is an occasional need for tacheometric work of greater accuracy than is possible with stadia equipment. The more elaborate double-image instruments are efficient when the work is extensive and demands the greatest accuracy. These tacheometers are quite heavy and expensive, and all require costly staffs.

Hence, it may be said that the stadia instruments are more suitable when speed, simplicity and low cost are more essential than the ultimate accuracy. The self-reducing types are economical when traversing or topography is done more or less continuously. The double-image tacheometers are capable of greater precision at the expense of speed and cost. The stadia instruments probably have the greater appeal to American surveyors.

[5] The Barot micrometer measures fractions of units on the vertical rod. Its use detracts somewhat from the advantage of speed held by the stadia instruments.

ERRORS IN TACHEOMETRIC MEASUREMENTS

The surveyor is naturally concerned with the accuracy that may be obtained from tacheometer instruments. The errors come from three general sources:

1. Errors in reading the rod.
2. Errors due to observing conditions, as wind, refraction, etc.
3. Errors in the instrument, including the value of the constant.

The first two affect the accuracy of the intercept. The third source may be minimized by maintenance of adjustment and frequent calibration.

There are various formulas based on the theory of least squares for predicting the error. Probably the most simple one is based on the assumption that the maximum error in estimating the reading of a rod graduated to 0.01 foot, in good atmosphere, is one half division, or 0.005 foot. The average error may be taken as half this. Then, the average error of the intercept is $0.0025\sqrt{2} = .0035$ ft. This amounts to 0.35 foot in the distance. However, the ability to accurately read the rod varies with the distance, type of rod graduation, magnifying and resolving power of the telescope, illumination, elimination of parallax, stability of the rod, and atmospheric condition at the moment. These are too variable to pin down to a definite figure.

The theoretical probable error of the stadia distance is sometimes expressed in terms of the probable errors in the stadia ratio, k, the intercept, s, and the angle of inclination, a, as follows.

Differentiating the equation, $D = ks \cos^2 c$, gives $dD = s \cos^2 a\ d\ k + k \cos^2 a\ d\ s - 2\ ks \cos a \sin a\ d\ a$. Substituting in this the value of $\cos^2 a = D \div ks$ from the original equation,

$$dD = D\left(\frac{dk}{k} + \frac{ds}{s} - 2 \tan a\ d\ a\right). \quad (13)$$

In order to express dD as the probable error in D in terms of the probable errors of k, s and a in seconds of arc, we have,

$$e_D = D\sqrt{\left(\frac{e_k}{k}\right)^2 + \left(\frac{e_a}{s}\right)^2 + 4\ (\tan a\ e_a \text{ arc } 1'')^2} \qquad (14)$$

In common with all purely theoretical approaches, this formula is of little practical use for evaluating a single measurement. The error in the intercept is, or should be, much greater than the others. The uncertainty due to this, when expressed as a ratio of the distance, will be larger for short sights. On the other hand, the uncertainty will increase rapidly beyond the range of clear vision. The range of sights giving the minimum proportional error will usually lie between 400 and 600 feet, depending on the optical qualities of the telescope and the stability of the atmosphere.

An error in the constant, k, will cause an error in distance proportional to the distance. Maladjustments of levels, vertical index, etc. will affect height differences. Refraction also affects heights, and distances. The tendency is to increase the intercept, hence is systematic.

The errors of the double-image tacheometers are quite similar to those of the stadia. Errors due to vertical refraction are eliminated by the use of the horizontal staff, but horizontal refraction may be encountered when sighting near obstacles. The parallactic angle, having no association with the focal length, should be subject to less error than in the case of the stadia. Staff readings are also superior, and extremely long sights are not possible. Hence, the double-image tacheometers are generally more accurate than the stadia types.

The condition of the instrument as regards fit of parts, wear, lost motion, stability, etc., is an important factor in the overall accuracy. Naturally, the more-complicated self-reducing models are subject to greater wear and tear. The manufacturers make a special effort to maintain the quality and stability of instruments intended primarily for use as tacheometers.

Most experienced surveyors are of the opinion that the maximum accuracy of stadia measurements taken under average field conditions is in the order of 1 part in 600. It may reach 1 in 1000 under particularly good conditions and with first quality equipment. Between 1 part in 5,000 and 1 part in 10,000 is claimed for the best double-image tacheometers under ideal conditions. Probably 1 in 1000 to 1 in 2000 can be expected under average conditions.

The accuracy of elevations varies greatly with the profile. Under average conditions, the closure between bench marks should never exceed $0.01\sqrt{D}$ in feet. With the exercise of proper care, it may be expected to fall within that limit.

Coast Survey Journal

The latest issue of *The Journal of the Coast and Geodetic Survey* (August 1955, No. 6) was released in April 1956. This Journal, under the able editorship of A. L. Shalowitz, former editor of SURVEYING AND MAPPING, contains many articles of great interest to those in the surveying and mapping profession.

The following titles of the articles contained in this issue are selected as the ones most apt to be of special interest to most of the readers of SURVEYING AND MAPPING:

Geomagnetism in the International Geophysical Year
Movement of Triangulation Marks Set in Permafrost
Radio Wave Propagation as Applied to Shoran
Geodetic Work of the Coast and Geodetic Survey
Three Seasons at Pitt Point, Alaska
On Duty With the Inter-American Geodetic Survey
Mapping the Earth
Report of Committee on a Loose-Leaf National Atlas
Resection by Intersection
The Three-Point Problem
Some Legal Aspects of the Work of the Coast and Geodetic Survey
The "Automatic" Level
Acetate Drawings
Army Map Service

This publication is paper covered, contains 190 pages, is 8 by 10½ inches in size, on "slick" paper, and profusely illustrated. It is for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at $1.50 per copy.

The Self-Indexing Alidade

By WARD H. BOLTER

KEUFFEL & ESSER CO.

PROBABLY the most fundamental mapping instrument ever developed is the plane-table alidade. Before the days of aerial mapping, it was used exclusively for locating topography for all large mapping projects. Today, it is the primary instrument for filling in map areas and map details that cannot be photographed from the air, and it is used extensively for making ties to photocontrol points. It is the basic instrument for the geologist and the most versatile device ever developed for mapping small areas.

The telescopic alidade was originally developed by the United States Geological Survey in the late 1800's.

The familiar form of this instrument now in use was introduced about 28 years ago. It is a tribute to the United States Geological Survey's design that it has been changed so little during this long interval.

We now have a successor to this instrument that is entirely different in design, and because tests have proved that it is so much more accurate and faster to operate, I feel it should be brought to the attention of this Congress. It is called the "Self-Indexing Alidade."

This new alidade had its inception about five years ago when the United States Geological Survey first conceived the idea that some means should be found to set the slope indices automatically. As you all know, no plane-table board can be leveled accurately enough to provide a truly horizontal base for measuring vertical angles. The segment that carries the indices used with the vertical arcs must, therefore, be set according to the true horizontal for every observation. Heretofore, an index or control level attached to the segment has proved to be the most convenient means of accomplishing this result. With this device, it is necessary to center the bubble of the control level before every slope determination.

In an attempt to eliminate this source of delay and error, the Geological Survey conceived the idea of *mounting the circle on a pendulum*. While this idea is fundamental and quite easy to understand, it introduces some practical difficulties. The pendulum must be hung so that the friction developed by its support will be practically non-existent, the swing of the pendulum must be rapidly damped out, and its support must be protected from damage when the instrument is moved from place to place.

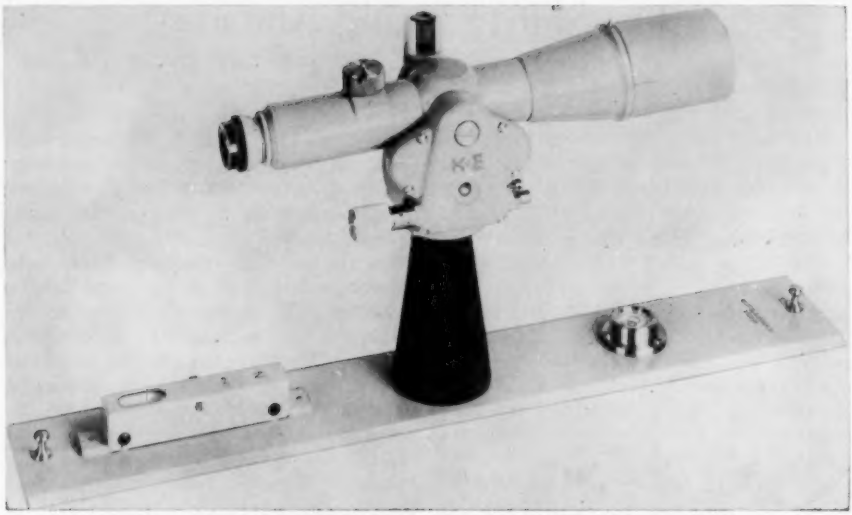
The Survey built one or two pilot models that were so carefully designed that they were an immediate success. At about this time, Keuffel & Esser Co. had been considering changes in the design of the alidade. The work of the Geological Survey gave new impetus to this effort, and work was begun in earnest on an entirely new design, which included the idea of a pendulum.

We decided to throw away all previously conceived ideas of how an alidade should be made and what features were necessary. The first of this new model alidade is here on the platform. Notice that there is no striding level. As a matter of fact, there are no reticule adjusting screws, the telescope cannot be rotated in the telescope axle, all precision parts are entirely enclosed, and both the telescope itself and the supporting parts are practically sealed from dust or moisture penetration.

It was decided to make the new instrument optical-reading so that a glance in the scale-reading microscope would present the three scales in one position, enlarged and illuminated.

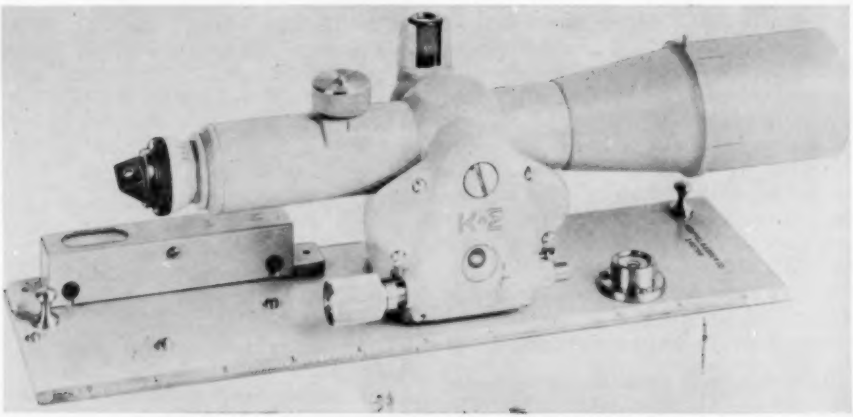
The most important new part is the pendulum which is suspended on a metallic membrane. It was found that a metallic membrane could be made that was tough

Presented at the Sixteenth Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., March 19–21, 1956.

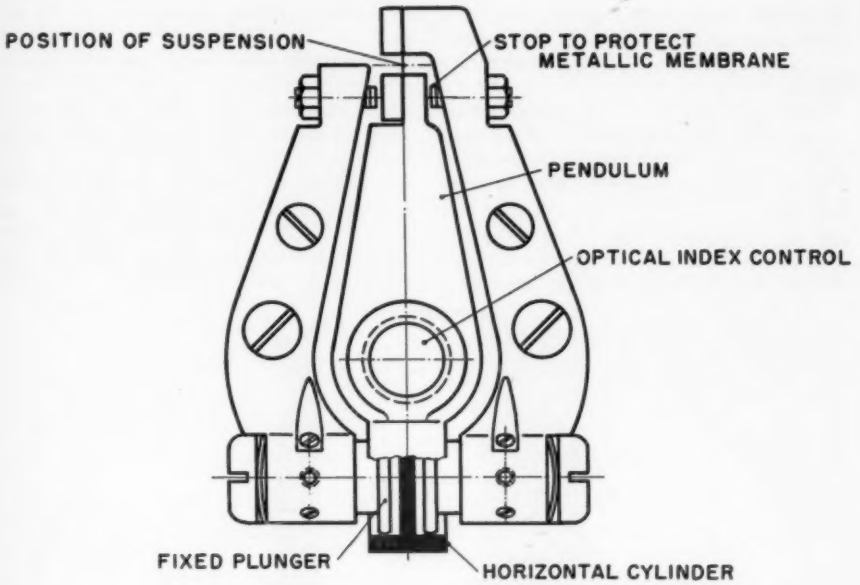


K&E PARAGON SELF-INDEXING GEOLOGICAL SURVEY ALIDADE

and yet so flexible that it had no effect on the position of the pendulum throughout the $\pm 1°$ through which it swings. At the lower end of the pendulum are two horizontal cylinders, back to back, shaped like shallow cylindrical cups. As the pendulum swings, the cylinders move over fixed plungers that clear the inside surfaces of the cylinders by 0.001 inch along the radius. The resistance of the air to movement in and out of these cylinders provides the necessary damping action without affecting the final position of the pendulum. The swing of the pendulum is limited by the contact of the plungers against the ends of the cylinders. The plungers also prevent the pendulum from moving upward when the instrument is carried, which might otherwise cause the metallic membrane to buckle. Two stops are provided at the upper end



K&E PARAGON SELF-INDEXING EXPEDITION ALIDADE



PENDULUM DAMPING MECHANISM

of the pendulum to prevent a movement of this end large enough to damage this membrane.

It is evident that the pendulum can swing freely between the plungers only when the instrument is nearly level. However, it is designed to swing freely even when the plane-table board is tilted more than would be proper for ordinary use. In addition to the small circle on the circular spirit level that is used to level the board, a large safety circle is provided. When the bubble is within this larger circle, the pendulum is always free to swing.

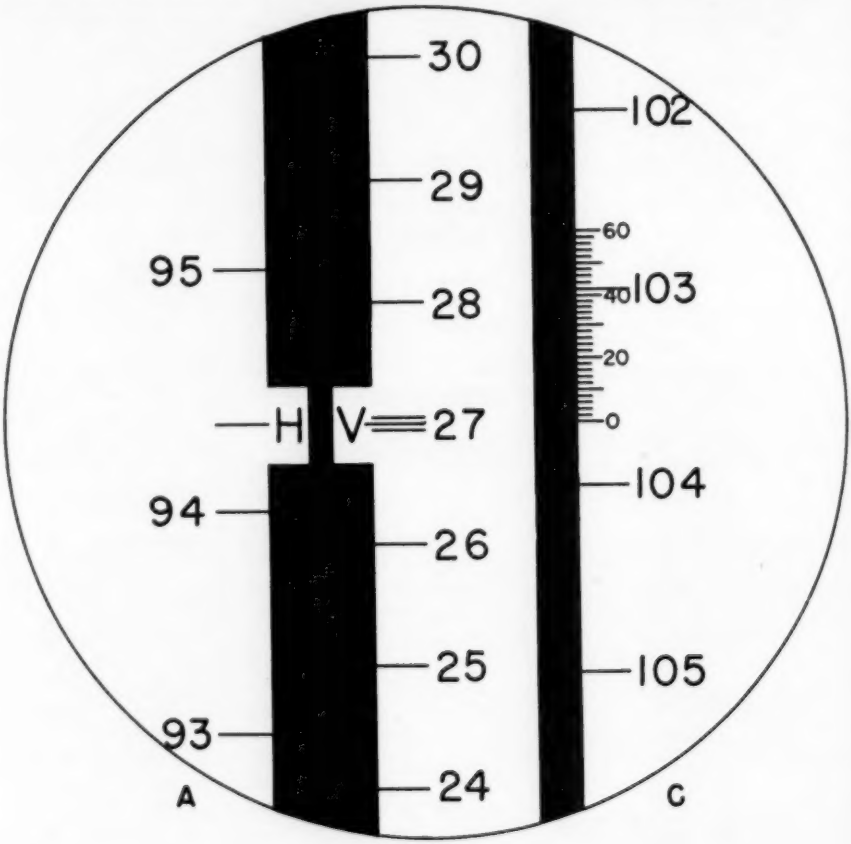
The light for optical reading is collected by a large, almost semi-spherical, condensing lens at the side of the instrument. It will collect light over a very wide angle of incidence, so that no mirror is necessary to direct the light into the instrument. This eliminates the time necessary to adjust a mirror. Directly behind the lens is the glass vertical arc that moves with the telescope and on which are placed the three scales, i.e., the horizontal and vertical multipliers and the elevation-angle scale. The scales are arranged parallel to each other and placed so that all three can be read at the same place on the arc. The light from these scales passes through an optical train which forms an image of the scales on the indices on the reticule where they are observed through the microscope. On the way, the light passes through an optical part in the pendulum which brings the correct scale readings on the indices.

The microscope is conveniently located on the top of one of the standards. The optics are such that the eye does not have to be brought very close to the eyepiece in order to take a reading. The observer sees the three indices lined up beside each other. The vertical stadia-multiplier index consists of a pair of lines between which the percent mark can be accurately centered before the rod reading is taken. The horizontal index is a single line by which the horizontal multiplier can be estimated to the nearest tenth of a percent. The vertical-angle index is a scale one degree long

graduated every two minutes, numbered every 20 minutes, by which the vertical angle can be estimated to the nearest half minute.

The optics of the main telescope have been completely redesigned. We believe that it is the finest telescope that Keuffel & Esser Co. has ever designed. The telescope has an achromatic doublet objective lens and an achromatic triplet eyepiece. The power is 16 diameters. Internal focusing is used so that the stadia additive constant is negligible. All lens surfaces are coated except the first and last. The focusing knob is on top for convenience, and open finder sights are provided.

As mentioned previously, the reticule is fixed in the telescope so that there is no means of adjusting the direction of the line of sight in the field. In addition, the telescope is fixed in the telescope axle so that it cannot be rotated within the axle. These two features constitute an important departure from standard design. The deci-



A. HORIZONTAL MULTIPLIER READS - 94.4
B. VERTICAL MULTIPLIER READS - 27.0
C. ELEVATION ANGLE SCALE READS - 103°42

VIEW THROUGH SCALE-READING EYEPIECE

sion to make this change was accepted only after a careful analysis of the geometry involved. An error in the vertical position of the reticule would, of course, have no effect, as the pendulum is adjusted according to the slope of the actual line of sight. The only source of error would be the effect on the veritcal angle when the reticule was displaced left or right. It was found that under maximum conditions—when a vertical angle of 30° was measured—the reticule would have to be displaced left or right 46 thousandths of an inch to cause an error in the vertical angle of ½ minute. As it is a simple matter to hold this tolerance to a few thousandths of an inch in manufacture and assembly, the error is negligible. For example, 3 thousandths of an inch would cause an error of one thousandth of a second.

Once the decision to use a fixed reticule is reached, many advantages follow. The reticule cannot get out of adjustment, no striding level is required, the telescope can be fixed in its axle, no collars are necessary for the telescope, worn collars or other parts cannot affect the adjustment of the instrument, and only one field adjustment of the instrument is required.

The one field adjustment required is the adjustment that causes the index to give the correct reading for a given slope of the line of sight. This is made with a large capstan-head screw with locking nut acting against an opposing spring. Turning this screw provides a very slow movement in the optical train that will take up any slight error. The control of this movement is so rugged that once set, there is very little chance that it can ever get out of adjustment. The standard peg test can be used exactly like the test for the dumpy level or the telescope level on a transit.

A more simple test can be used if an ordinary level in good adjustment is available. Merely focus the level at some distant point, and thus place the principal focus of the objective lens at the cross lines. All the light rays from the cross lines will then be parallel to each other when they emerge from the objective lens and, in fact, the level will have become a collimator. When the bubble of the level is centered, these rays will be exactly horizontal. The line of sight of the alidade is then aimed through the objective lens of the level at the cross lines that can be seen through it and is thus made to coincide with one of the horizontal rays. In this position, it is exactly level and the vertical circle should indicate horizontal. If the test is made indoors, the eyepiece of the level should be aimed toward a window to provide an illuminated background for the cross lines.

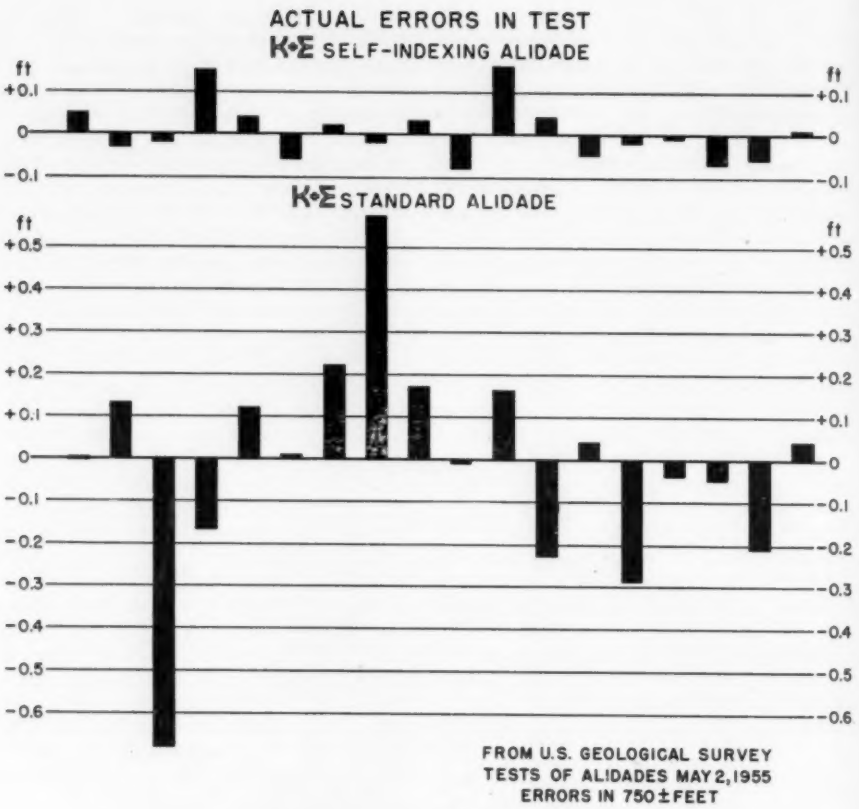
The vertical angle of the alidade is, of course, regulated by a tangent screw acting against a counterspring. If desired, the spring and tangent screw can be interchanged. In one position, the tangent screw can be operated from the back of the instrument; in the other position, it can be operated from the front of the instrument. The tangent screw can be equipped with a gradienter drum.

There is no vertical clamp. The angle of the telescope is held by the friction of a special, flat, resilient washer that surrounds the end of the telescope axle. The degree of friction can be regulated by a large screw that can be turned with a coin. Thus, the telescope can be approximately aimed as though the clamp were free and immediately regulated with the tangent screw as though the clamp were tight.

It should be pointed out that the tangent screw is not the endless type, but marks are provided to indicate the center and the limits of its travel.

A removable prismatic eyepiece is provided. The pedestal is covered with a special plastic that gives a firm grip for handling the instrument. This eliminates loose cord around the pedestal. The trough compass has a 2¾″ Alnico needle that is induction damped. All outer corners on the instrument are rounded to further facilitate handling and the exterior color is light sand to decrease the absorption of radiant heat.

The new carrying case rests in and is cemented to a sponge-rubber pad, eliminating the conventional four rubber feet which are easily knocked off. The conventional



RESULTS OF COMPARATIVE TESTS

leather strap with its buckle is replaced by a fungus and mildew resistant web strap with a quick releasing clamp closure.

TESTS

A pilot model was given to the United States Geological Survey for test. First, a group of experienced topographers gave it a thorough examination. These men, from their wide experience, pointed out every feature that might facilitate the use of the instrument in the field. Their suggestions have been included in the production model you see here. Then, the instrument was given a field test.

The field test was made with several types of alidades over a series of eight turning points between two benchmarks about a mile and a quarter apart. The elevations of these points were first determined by conventional precise-leveling methods. This gave a series of ten points of known elevation separated by intervals averaging about 730 feet. The run was made twice with each alidade giving 18 determinations of known differences in elevation. The errors per determination for the standard Keuffel & Esser Co. alidade were as follows:

Average Error	0.174 Ft.
Probable Error	0.170 Ft.

The errors per determination for the Self-Indexing Keuffel & Esser Co. instrument was as follows:

Average Error	0.051 Ft.
Probable Error	0.044 Ft.

These figures indicate that the errors to be expected with the new instrument should be only 25% to 30% as great as the errors with the standard instrument. In other words, the new instrument is nearly four times as accurate.

New Deck Officers Appointed

Releases in February and March announce the appointment of four new deck officers in the Coast and Geodetic Survey.

Albert Larsen, Jr., 267 Decker Ave., Staten Island, N. Y., a graduate of Manhattan College, was appointed February 9, 1956, and assigned to the Ship *Explorer* for hydrographic survey work in Alaskan waters during the summer season.

Leroy W. Heilman, R.R. 2, Freeburg, Ill., a graudate of the University of Illinois, was appointed March 5, 1956, and assigned to the Ship *Hydrographer* for hydrographic survey work in the Gulf of Mexico.

Herman H. Druebert, 162 East Faust St., New Branufels, Tex., a graduate of the University of Texas, was appointed March 6, 1956, and assigned to the Ship *Pathfinder* for hydrographic survey work in Alaskan waters during the summer season.

Charles I. Harding, 562 Flint St., Mobile, Ala., a graduate of Alabama Polytechnic Institute, was appointed March 15, 1956, and assigned to the Ship *Cowie* for hydrographic survey work in the Chesapeake Bay area during the coming season.

Discharges of the Mississippi River

"Annual Maximum, Minimum, and Mean Discharges of the Mississippi River and its Outlets and Tributaries to 1953" is the title of a publication recently released by the Mississippi River Commission, Corps of Engineers, U. S. Army. The publication contains data relating to the annual maximum, minimum, and mean discharges, through incorporation and utilization of all available records, published or unpublished, of the Corps of Engineers of the Department of the Army, including the Mississippi River Commission, and the Geological Survey of the Department of the Interior.

The following is quoted from the Introduction in the publication:

> Although this report covers the Mississippi River watershed, the list of stations for which records are available is not complete; however, most of the stations listed are in the Lower Mississippi Valley. * * *
>
> As a result of extensive research, revisions and additions have been made to previously published records. The maximum and minimum figures shown are either measured, interpolated or extrapolated, derived or estimated discharges. Measured discharge by meter method is preferred to those by float method, when both are available, if made on or near the presumed maximum or minimum flow conditions. Momentary values are shown where available, otherwise, values are for mean daily or at eight o'clock. The maximum and minimum discharges for the period of record are underscored.

The detailed data are presented in tabular form, one table for each discharge station. Dates of both maximum and minimum discharges are shown.

A unique feature of this publication is that blank spaces are left at the end of each table for later insertion of the appropriate data for the years 1953 to 1963, inclusive.

The publication is paper covered, 6 by 9 inches in size, contains 147 pages, and is priced at $1.00. It may be obtained from the Office of the President, Mississippi River Commission, P. O. Box 80, Vicksburg, Miss. Remittances should be made payable to the Treasurer of the United States.

How Accurate Is That Map?

By MORRIS M. THOMPSON

U. S. GEOLOGICAL SURVEY

IF YOU SHOULD ASK a fisherman whether he considers the topographic map of the local area to be accurate, he might tell you something like this: "Of course it's accurate. Look here—this is my cabin, here is the access road; there is the crossroad with the store and filling station; this crooked line shows all the bends in Nine-Mile Run; these brown contours close together show Porcupine Hill and the figure on top shows its elevation to be 845 feet. What else would a man need to know?"

Now ask an engineer about the same map and he might answer in this vein: "I can only use that map to a limited extent because it isn't accurate enough to meet all my needs. It shows 20-foot contours to half-interval accuracy. That means that I have a 10-foot doubt about the elevation of any point. The pool line behind the dam planned for Nine-Mile Run has to be determined to one-foot accuracy. We can't tolerate any doubt as to whether the crossroads, for example, will or will not wind up in the lake. So we have to mark time while the pool line is run out. If the existing map had been accurate to one foot we would have had a big jump on our planning."

The question of whether the map should be made for the fisherman or the engineer is beyond the scope of this discussion.[1] Suffice it to say that a map is made in accordance with some established policy concerning what is needed, and these needs are the basis for establishing the interrelated factors of publication scale, contour interval, and accuracy specifications for that map. In this context, "accuracy" refers to a quantitative measure of the degree of conformance of map detail with the actual features on the ground.

The mapmaker responsible for planning or executing a mapping operation cannot help but view the accuracy specifications with an extremely critical eye. These specifications have a direct bearing on the number of man-hours and dollars that will be expended in making the map. They influence the selection of field or photogrammetric methods, the kinds of instruments to be used, the flying height of aerial photography, the amount and distribution of control, the caliber of personnel to be employed, and the amount of accuracy checking required. Faced with these economic facts of life, mapmakers must have accuracy specifications that are clear, informative, and scientific. Essentially, the purpose of this paper is to examine methods of specifying map accuracy and to see what changes, if any, need to be made in existing specifications. If any changes are advocated, they will be for the purpose of providing clearer or more precise specifications, not to increase or decrease the accuracy required.

The principal components of map accuracy may be listed as follows:

1. Accuracy of factual information
2. Horizontal accuracy
3. Vertical accuracy

Each of these components will be examined in turn.

ACCURACY OF FACTUAL INFORMATION

The topographic map covering my home community is generally very reliable. At the same time, the map contains an error of fact which could be disastrous to a person

Presented at the Sixteenth Annual Meeting of the American Congress on Surveying and Mapping, Washington, D. C., March 19–21, 1956.

Publication authorized by Director, U. S. Geological Survey.

[1] The question is discussed in "Selection of Contour Intervals (A Panel Discussion)," published in SURVEYING AND MAPPING, October–December 1952, Vol. XII, No. 4, page 344, and in "Contour Interval Problems," by George D. Whitmore, SURVEYING AND MAPPING, April–June 1953, Vol. XIII, No. 2, page 174.

who would follow it too literally. It shows the street on which I live proceeding northward past my house and changing from a paved street to a second-class, unimproved (but presumably passable) road, eventually connecting with another through street. Actually my street turns abruptly to the west into a second street at the point where the map shows the second-class road beginning. A motorist who attempted to proceed northward according to the map would crash into a wooden barrier at the sharp left turn. If the barrier didn't stop him, he would find himself careening down a precipitous slope towards a dense stand of oak trees. If by expert handling of his car he managed to thread his way through the woods, he would next be crossing a sizeable creek, except that there is no bridge there and never was. If he didn't drown and could jockey his car up the opposite bank, he would then indeed be back on the course shown by the map.

This is cited as an extreme example of an error in factual information. It can be assumed that gross errors of this kind would rarely appear on a competently-made topographic map that had been adequately checked before publication. But lesser errors of fact do get by on maps that are considered to meet the usual accuracy standards. Names and symbols of features and classification of roads or woodland are among the principal items that are subject to factual error. It is not possible to apply a numerical value to individual errors of fact; a given item of information is either right or it is wrong. Apparently there is a tacit understanding that factual errors on a well-made topographic map will be negligible; at any rate, the usual accuracy specifications generally make no mention of the accuracy of factual information. The only attempt to apply a yardstick to such accuracy, that we have discovered, is a statement in a British publication to the effect that errors of fact should not exceed one or two per hundred thousand words or symbols.[2] Although American general-purpose maps probably do not attain this high an accuracy, the rather thorough checking that is generally practiced by makers of precise maps, as a matter of professional integrity, tends to keep factual errros to a practical minimum. Thus, it does not appear desirable to include a factual accuracy requirement in topographic map specifications.

HORIZONTAL ACCURACY

Determination of errors

Specifications for horizontal accuracy are usually stated in terms of the departure of points on the map from their true positions. Thus, if the plotted position of the center of a crossroads is found to be 10 feet from the true position as determined by precise field survey, we state that the horizontal error of the map at that point is 10 feet.

It is also possible to state the horizontal accuracy in terms of the departure of "planimetric features" (rather than points) from their true positions. This makes the determination of error somewhat more complicated if the feature is an aligned feature such as a road or railway. In figure 1, the solid line AB indicates the map position of a railway tangent and the dashed line A′B′ indicates its true position. What is the planimetric error of AB? Is it the average distance between AB and A′B′? Is it the maximum distance, AA′? Or should it be expressed as an angular value, A′OA, com-

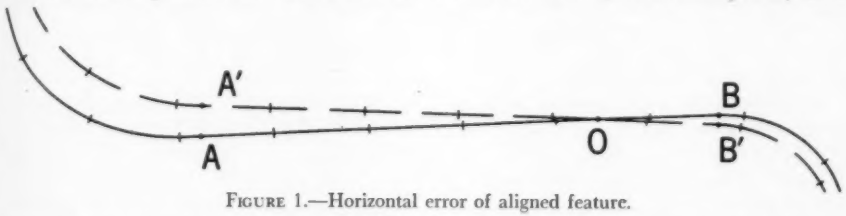


FIGURE 1.—Horizontal error of aligned feature.

[2] CRONE, COLONEL D. R.: The Accuracy of Topographical Maps," *Empire Survey Review*, Vol. XII, No. 88, April 1953.

bined with the maximum difference, AA'? Actually, the last of these would give the most complete description of the error in the position of this individual feature; but the task of determining the angular error for all aligned features would be prohibitive in cost. It can be assumed, therefore, that horizontal accuracy determination should invariably be based on the positions of identifiable points rather than on the location and orientation of features having length or area.

It is pertinent to mention, at this point, a factor in horizontal-accuracy determination which has long been recognized and presents no difficulty for those familiar with accepted practice in map preparation and the limitations of maps at different scales, but which might possibly bother persons of less experience. That factor is the displacement of roadside features arising from the long-standing practice of double-line, standard-width road symbolization (*See* figure 2.) If a road that is actually 20 feet wide is drawn 50 feet wide on the map, retaining the correct centerline, then a roadside object must de displaced 15 feet in a direction perpendicular to the road. If there is another object that is actually 15 feet farther back from the road, the mapmaker faces the dilemma of whether to displace the second object or leave it in its correct position, which would be incorrect relative to the displaced first object. Standard practice is to displace only those objects that have to be displaced to maintain clearance between the object and the road. (Positions in a direction parallel to the road are not affected by this shift.) Obviously, a distorted picture of the horizontal accuracy of the map would be obtained if displaced roadside objects were used as check points without recognition of the displacement factor; an experienced map checker, however, would not be likely to fall into such a trap. This could become a less serious factor if map users could be induced to accept the symbolization of roads by a single line, rather than by double lines.

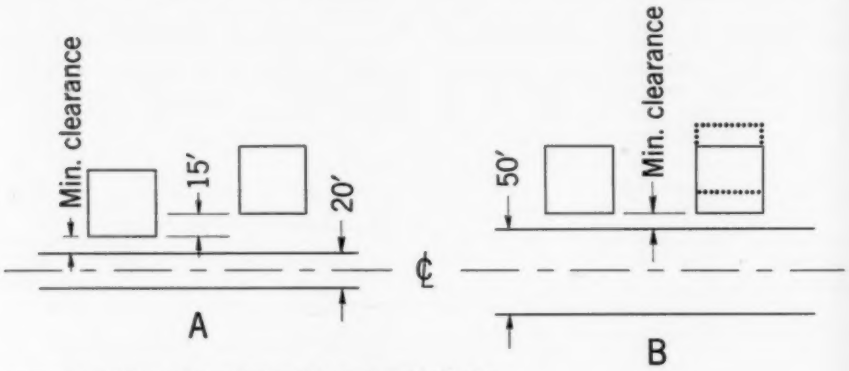


FIGURE 2.—Effect of standard-width road symbolization.
A. Road and house at true scale.
B. Roadside detail adjusted to accomodate conventional road width. Solid position of right-hand house is correct relative to centerline of road; dotted position is correct relative to left-hand house.

What yardstick for horizontal accuracy?

Thus far, we have settled on the fact that horizontal accuracy is best evaluated by finding errors at individual points. The next question is: supposing that we have a list of horizontal errors at an adequate number of points, what yardstick should be applied in order to evaluate the accuracy of the map as a whole?

American map-accuracy specifications are traditionally stated in the form: "Ninety percent of the points tested shall be correct

within (a given amount)." It has been pointed out that these specifications have been in use for some 40 or 50 years and have the virtues of simplicity and familiarity.[3] Also, the fact that the specifications have adequately served the need for so many years indicates that they were extremely well conceived, in their time. A recognition of these virtues, however, need not cause us to overlook the fact that there may be room for improvement. Two principal reasons for desiring a modification of the usual specifications are advanced:

1. The form of the specifications does not agree with standard scientific terminology. All the countries of Europe, including Great Britain, express map accuracy in terms of the standard deviation (or mean square error). The standard deviation, d, is defined simply as $d = [\Sigma e^2/n]^{\frac{1}{2}}$, where e = error at each point, and n = number of points. The same scientific terminology is used in other fields of science in the United States. It has already been shown that the existing American specifications are readily converted to a mathematical equivalent in terms of standard deviation.[4] As this conversion needs to be made for studies of various kinds, it seems reasonable that we should adopt the statistical language that is universally accepted in the rest of the world.

2. The existing form of specifications is not sufficiently informative in that it does not reflect the size of the errors on either side of the allowable tolerance. For example, if the horizontal accuracy specifications state that 90 percent of the points tested shall be correct within 40 feet, the 10 percent of allowable excessive errors could consist entirely of 41-foot errors or entirely of 100-foot errors and it would make no difference in the stated accuracy of the map. Likewise, it would make no difference if the 90 percent within the tolerance consisted entirely of 40-foot errors or entirely of zero errors. A "horrible example" or how a poor map could pass and a good map could fail under these specifications is given in a previous article in SURVEYING AND MAPPING.[4]

On the other hand, the standard-deviation specification takes every test point into account and reflects the entire range of errors.

VERTICAL ACCURACY

Methods of defining contour accuracy

Accuracy as applied to contours can be determined in several different ways.

1. The positional accuracy of a contour can be measured as a horizontal distance between the map contour and the correct contour. For example, in figure 3,

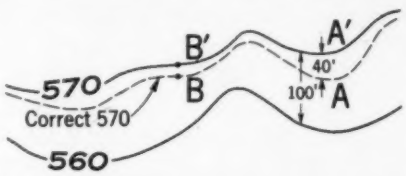


FIGURE 3.—Contour accuracy in terms of horizontal displacement of contours.

the solid-line 570 contour appears on the map, whereas the correct 570 contour as run out on the ground is shown by the dashed line. As the distance between the two varies, it is difficult to say what the position error is. It is more expedient to find discrete points on the ground at elevation 570 and determine distances normal to the plotted contour (as AA′ and BB′) which are the horizontal errors of the contour at that point. The amount of tolerance could be expressed as a certain fraction, say ½, of the horizontal distance between contours, measured in the direction of greatest slope at the point tested. Thus, in figure 3, the distance between contours is determined on the ground or map (as specified) to be 100 feet and the error AA′ amounting to 40 feet, would be within the half-distance tolerance of 50 feet. Generally, however, contour accuracy is not expressed in terms of horizontal displacement, but in terms of vertical error, as described below.

[3] *See* WHITMORE, footnote 1.

[4] THOMPSON, MORRIS M., and DAVEY, CHARLES H., "Vertical Accuracy of Topographic Maps," SURVEYING AND MAPPING, January–March 1953, Vol. XIII, No. 1, page 40.

2. The British Ordnance Survey[5] determines contour accuracy by locating points on the ground corresponding to the intersections of random lines with the contours as mapped; the elevation of each point is then determined and compared with the nominal height of the pertinent contour to obtain the contour error at that point. As shown in figure 4, the points marked by a dot on the map are located on the ground by measurements on the map and ground from the adjacent planimetric detail.

metric detail.[6] Thus, in figure 4, P would be an ideal check point, according to this system.

The difficulty with both of these procedures is that, while they may pay in a thickly settled country like Great Britain, the costs involved in applying them to vast areas of the United States would be prohibitive.

4. In the United States, it has long been the practice to determine contour accuracy by comparing the map elevations of

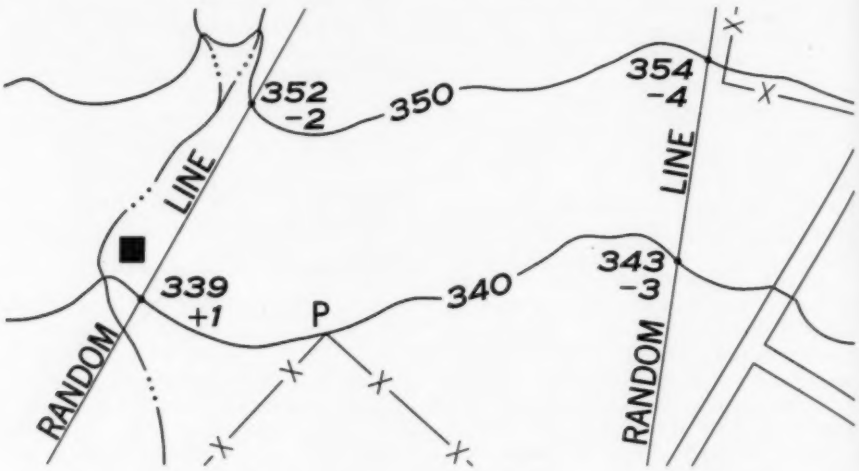


FIGURE 4.—Checking contour accuracy at intersections of contours and random lines of levels.

Levels are run along each random line, starting and closing on bench marks, and the height of each of the marked points is determined. The upper figure at each point represents the elevation found by field survey and the lower figure represents the error of the contour at that point. The contour accuracy for the entire map is determined from these errors in terms of standard deviation.

3. An extension of the Ordnance Survey method is advocated by some practitioners who would confine contour testing to places where the contours intersect planipoints, as determined by interpolation from the contours, with field-survey elevations on the same points. This practice is by no means specified in the National Map Accuracy Standards, which merely state:

> Vertical accuracy, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.

The interpolation of elevations from contours on the map is, of course, subject to

[5] Ordnance Survey Policy Statement No. 5, Annexure, Indication of Relief on Ordnance Survey Maps.

[6] *See* CRONE, footnote 2.

some error wherever ground slopes are not uniform. Nevertheless, with judicious placing of check points and due regard for the nature of the terrain, the interpolation method is, by and large, a convenient and economical means of determining contour accuracy.

The horizontal shift

A key factor in evaluating vertical accuracy is the clause in the standard specifications which states that "the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale." The practical application of this clause is generally known as the "allowable horizontal shift," and is interpreted as permitting the map checker, imaginarily, to shift contours horizontally as much as 1/50th inch on the map (equivalent to 40 feet on the ground when the map scale is 1:24,000) in order to reduce the apparent vertical error. A note of caution on applying the horizontal shift is in order. The shift should not be applied indiscriminately when the positional accuracy of a check point on the map is in doubt, for the shift added to an already erroneous position may result in an actual horizontal displacement exceeding the permissible horizontal error.

The allowable horizontal shift has the effect of increasing the vertical tolerance as the ground slope increases, in a manner that can be expressed mathematically.

A formula for vertical accuracy

It has been shown[7] that the existing vertical-accuracy specifications can be transformed to an equivalent formula in terms of standard deviation, thus:

$$d_v = d_o + bt$$

For a 1:24,000 scale map,

$$d_v = 0.3 \text{ C.I.} + 24t$$

where d_v = allowable standard deviation for all vertical check points
d_o = allowable standard deviation on flat ground
b = the horizontal tolerance expressed as standard deviation
C.I. = Contour interval
t = tangent of angle of slope

In this formula, the term "0.3 C.I." is the standard deviation that is mathematically equivalent to "90 percent of errors shall be within one-half contour interval." In the term $24t$, the coefficient 24 is the standard deviation that is mathematically equivalent to "90 percent of errors shall be within 40 feet," and this term converts the allowable horizontal shift into an additional vertical tolerance that is a function of the ground slope. The entire formula states, in effect, that on flat ground, the allowable standard deviation shall be not more than 0.3 of the contour interval, and as the slope increases, the tolerance increases. Formulas of this type have long been used for evaluation of map accuracy in other parts of the world.

It has been pointed out that a difficulty that could arise with this type of specification is the chance for difference of opinion between the mapmaker and the map tester on the degree of ground slope.[8] This is a valid objection if one thinks of the degree of slope as a prevailing value for a map or part of a map. But the difficulty can be met if the slope is determined separately at each check point, from the adjacent contours, and agreement on the slope at individual points should not be difficult. The appropriate slope allowance can be applied separately to each error, and the adjusted errors can then be used to determine the standard deviation, which would then be required to be within the tolerance for a slope of zero.

Effect of map scale on vertical accuracy

In the existing specifications for horizontal tolerance, 90 percent of points are required to be within 1/50 inch at publication scale, for scales of 1/20,000 or smaller. For different publication scales, there are, then, different horizontal tolerances expressed in feet on the ground, and these are the coefficients of t in the formula for

[7] *See* THOMPSON-DAVEY, footnote 4.

[8] *See* WHITMORE, footnote 1.

vertical tolerance, as the following table shows:

1/S	A.E. (feet)	d_h (feet)	d_v (feet)
1/24,000	40	24	0.3 C.I. + 24t
1/50,000	83	50	0.3 C.I. + 50t
1/62,500	104	62.5	0.3 C.I. + 62.5t

In the above table:
1/S = Publication scale,
A.E. = Allowable horizontal error for 90% of points,
d_h = Allowable horizontal standard deviation, and
d_v = Allowable vertical standard deviation.

It is interesting to note that d_h is always the same as the number of thousands in the scale denominator. This is due to a mathematical accident. It happens that 1/50 inch is 1/600 feet; it also happens that the standard deviation is, from error theory, 0.6 times the allowable error for 90 percent of points. We thus obtain $d_h = 0.6\ (S/600) = S/1{,}000$ feet.

It is also worthy of note that, for a given slope, the first term of d_v varies only with the contour interval and the second term only with the scale.

Figure 5 indicates the variation in vertical accuracy tolerances with the slope for 3 different scales, when the contour interval is 20 feet.

Comparison of American and international standards

One sometimes hears the complaint that American map-accuracy specifications are too tight. In a comparison of American tolerances with those of certain European countries it has been shown that ours are by far the loosest.[9] We can now compare our specifications with those set up by the International Society of Photogrammetry to govern the current testing of various compilation techniques. Agencies from many countries, including the United States, are participating in these tests, and one can, therefore, assume that these specifications have been widely accepted.

The international tests call for mapping with a 10-meter contour interval for publication at a scale of 1:50,000. To begin with, the horizontal tolerance for the international test is given as a standard deviation of 25 feet (7.5 meters) whereas the American allowable standard deviation would be 50 feet. The vertical tolerance, shown graphically in figure 6, is likewise some twice as much for American standards as for the international standards.

Consider what this would mean to an engineer who had to plan a photogrammetric mapping project observing the international accuracy requirements. He could not plan the photography by his usual criteria: C-factor information based on American specifications would be useless; the photography would have to be obtained at some guessed-at lower flying height; the control requirements would be multiplied because of the lower flight height; and costs would rise all along the line.

It appears that the present American requirements occupy a reasonable middle ground between the ultra-precision required for Europe's intensive land use and the cover-the-ground-never-mind-the-accuracy approach encountered in some places in this country. It is emphasized that, while this paper presents arguments for clarifying the existing specifications, it does not advocate a change in the degree of accuracy to be required.

Vertical-interval accuracy

There is one more aspect of vertical accuracy that is not mentioned in the existing specifications—the vertical-interval accuracy, meaning the accuracy of each contour with respect to adjacent contours. This is generally handled in the U. S. as a matter of topographic expression.[10] Yet we might do well to consider the British Ordnance Survey method of measuring vertical-interval accuracy. Referring to figure 7, point A, where the fence line cuts the 260-foot contour, is located on the ground by the checking party. The line of continuous greatest slope, AB, is drawn through A on the map, and the point B where this

[9] *See* THOMPSON-DAVEY, footnote 4.

[10] *See* WHITMORE, footnote 1.

line cuts the 250-foot map contour is located on the ground. The difference in elevation between the two points is determined by ground survey and compared with the nominal contour interval, 10 feet, to determine the error in vertical interval. A sufficient number of such error determinations are made to calculate a standard deviation

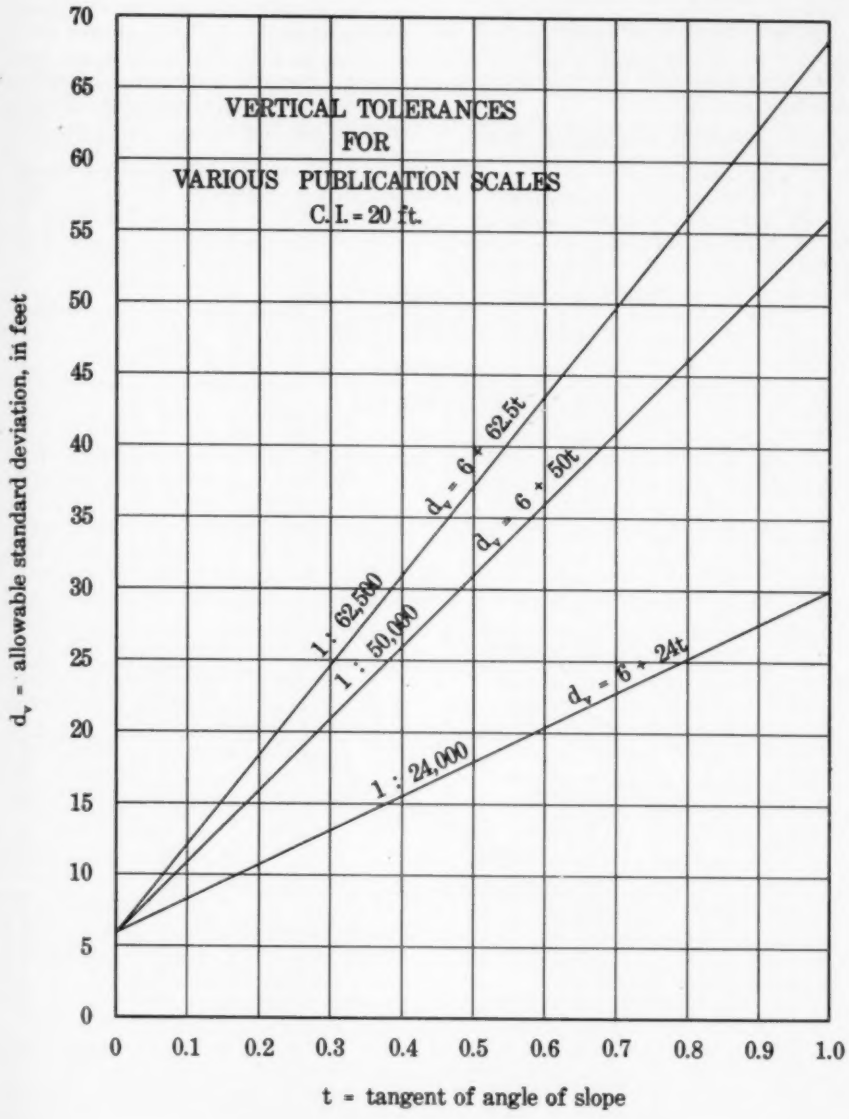


FIGURE 5.

tion for vertical interval. A tolerance of *one-fifth* of the contour interval is allowed in British practice.

ACCURACY CHECKING

In order that a clear picture of map accuracy may be obtained, it is necessary that the accuracy-checking procedure meet certain requirements.

1. The checking procedure should be uniform insofar as the terrain permits. If differences in terrain necessitate variations in checking procedure, the number of variations should be held to a minimum.

2. The checking procedure should be of a higher order of accuracy than the compilation procedure. Positions and elevations obtained by the checking procedure should be accurate enough so that comparison with map positions and elevations gives an essentially true picture of map errors.

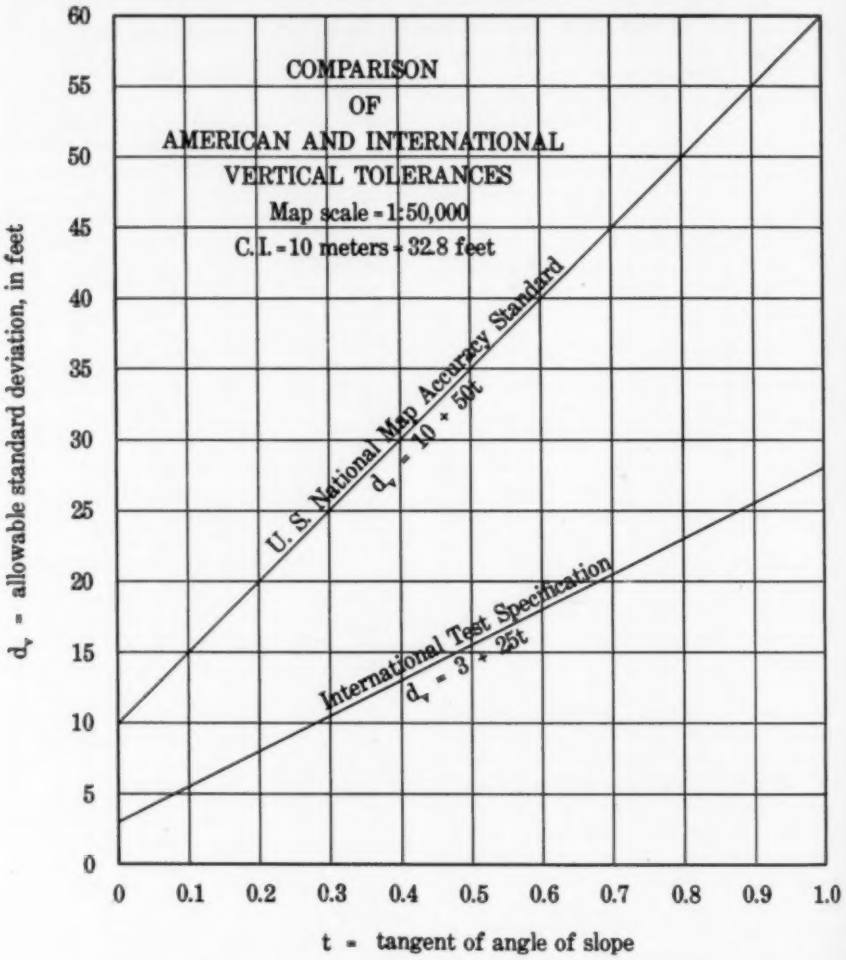


FIGURE 6.

3. Checking should be extensive enough to provide a sound basis for statistical analysis of the results. The greater the number of points checked, the more likely it is that the errors will follow a normal distribution pattern.

4. Check points should be so chosen as to fairly represent the overall quality of the map.

Inasmuch as the generally accepted accuracy specifications do not stipulate the method of checking, it has been left to each mapmaking or map-using organization to work out its own checking procedures.

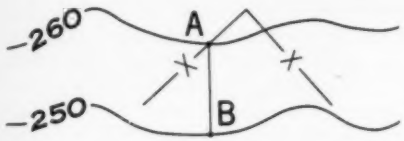


FIGURE 7.—Determination of accuracy of vertical interval.

The Geological Survey, recognizing the need for improvement in its own accuracy-checking procedures, recently completed a preliminary draft of a new chapter of its Topographic Instructions, to be entitled "Accuracy Testing Surveys." This chapter spells out in detail the procedures for checking and testing Geological Survey topographic quadrangle maps, and methods of analyzing and interpreting the results. The text is presently in the course of revision. When it is finally adopted and published, it should be of the utmost interest to all who are concerned with map accuracy.

CONCLUSIONS

In the light of this discussion, the writer presents, as his individual opinion, the following conclusions:

1. Horizontal- and vertical-accuracy tolerances should be expressed, in the universally accepted scientific language, as standard deviation (or root mean-square error).

2. The "allowable horizontal shift" should be eliminated in evaluating vertical accuracy. It should be replaced by an equivalent term in a formula expressing vertical accuracy as a function of the ground slope.

3. The coefficients used in the formulas for horizontal and vertical tolerance should be of such value as to make accuracy requirements equivalent in degree to the existing requirements. The purpose of the suggested revisions of the specifications is to provide clarity rather than to tighten requirements.

4. The possible need for a vertical-interval accuracy requirement should be studied.

5. Accuracy-checking procedures should be broadly standardized and made a part of the accuracy specifications.

If the American Congress on Surveying and Mapping can be instrumental in the promotion of a broad study of these suggestions, with perhaps some resultant action, it will have rendered another valuable service to the entire mapping profession.

M. I. T. Sponsors Surveying Exhibit

The Department of Civil Engineering at the Massachusetts Institute of Technology sponsored a major exhibit on "Applied Sciences in Modern Surveying" during February 1956.

The exhibit, for freshman orientation and to inform other engineers and scientists of the advances in modern surveying, included illustrative material on such subjects as optical instrumentation developments, geodimeter, electronic distance meter, shoran, raydist, electronic computers, plastic scribing, aerial photography, aerial cameras, and photogrammetric stereoplotters. Twelve different types of modern surveying instruments were displayed.

The exhibit, organized under the direction of Professor C. L. Miller with the assistance of cooperating private firms and government agencies, was viewed by an estimated 10,000 people and provoked considerable interest in modern surveying.

Application of the Least-Squares Method to Plane-Coordinate Conversion

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EVERY SURVEYOR is familiar with problem of analyzing and computing a new system of survey control points (traverse or triangulation stations) in such a manner that it fits into another system established by a previous survey. At least two points of the older survey have to be recovered and tied into the new survey to make a connection between the two surveys possible. In most cases, however, several of the old markers can be found and then the question arises as to which of these points should be selected to tie the two systems together. It certainly is desirable to employ a method which permits the use of all such common points.

The article "Novel Application for Transfer of Coordinates" by Carl D. Feltman (SURVEYING AND MAPPING, January–March 1955) describes such a problem and indicates which steps were taken to solve it. Mr. Feltman followed a procedure explained in more detail in Publication No. 2 of the Maryland Bureau of Control Surveys and Maps.

The following treatment describes the application of the method of least squares in the development of formulas which can be used to convert plane coordinates in one rectangular system to those in another.

For the general case the basic conversion formulas can be deduced from inspection of figure 1 as follows:

$$x = p + kX \cos \alpha - kY \sin \alpha \qquad (1a)$$

$$x = q + kY \cos \alpha + kX \sin \alpha \qquad (1b)$$

Let X_r and Y_r represent the coordinates of a point P_r in the local or temporary grid system, and x_r and y_r the given coordinates of the same point in the established or final grid system; p, q, k, and α are the conversion elements and the numerical values of these constants determine how closely the new survey will be fitted into the old one. The quantities, p and q, are the coördinates of the origin of the local grid system in the established system, α is the angle expressing the difference between corresponding bearings in the two systems and k is the distance factor. This is a constant close to unity with which all distances in the new survey have to be multiplied to keep the discrepancies to a minimum.

If X_r and Y_r are entered in formulas (1a) and (1b) the converted coordinates of point P_r are obtained:

$$x_r'' = p + kX_r \cos \alpha - kY_r \sin \alpha \qquad (2a)$$

$$y_r'' = q + kY_r \cos \alpha + kX_r \sin \alpha \qquad (2b)$$

Due to unavoidable errors in both surveys x_r'' and y_r'' will not be identical with the given coordinates of the same point, x_r and y_r. The discrepancies v_{rx} and v_{ry} can be expressed by the following formulas:

$$v_{rx} = x_r - x_r'' = x_r - p - kX_r \cos \alpha + kY_r \sin \alpha \qquad (3a)$$

$$v_{ry} = y_r - y_r'' = y_r - q - kY_r \cos \alpha - kX_r \sin \alpha \qquad (3b)$$

The total discrepancy for point P_r is given in formula (4):

$$v_r = \sqrt{v_{rx}^2 + v_{ry}^2} \qquad (4)$$

According to the theory of the least-squares method, the sum of the squares of the total discrepancies, v, must become a minimum. If the coordinates of n points are given in both coordinate systems, the conversion elements p, q, k, and α must have such values that this condition is met. If the sum of the squares of the total discrepancies is designated S, formulas (5) and (6) express that sum:

$$S = v_1^2 + v_2^2 + \ldots\ldots + v_n^2 \qquad (5)$$

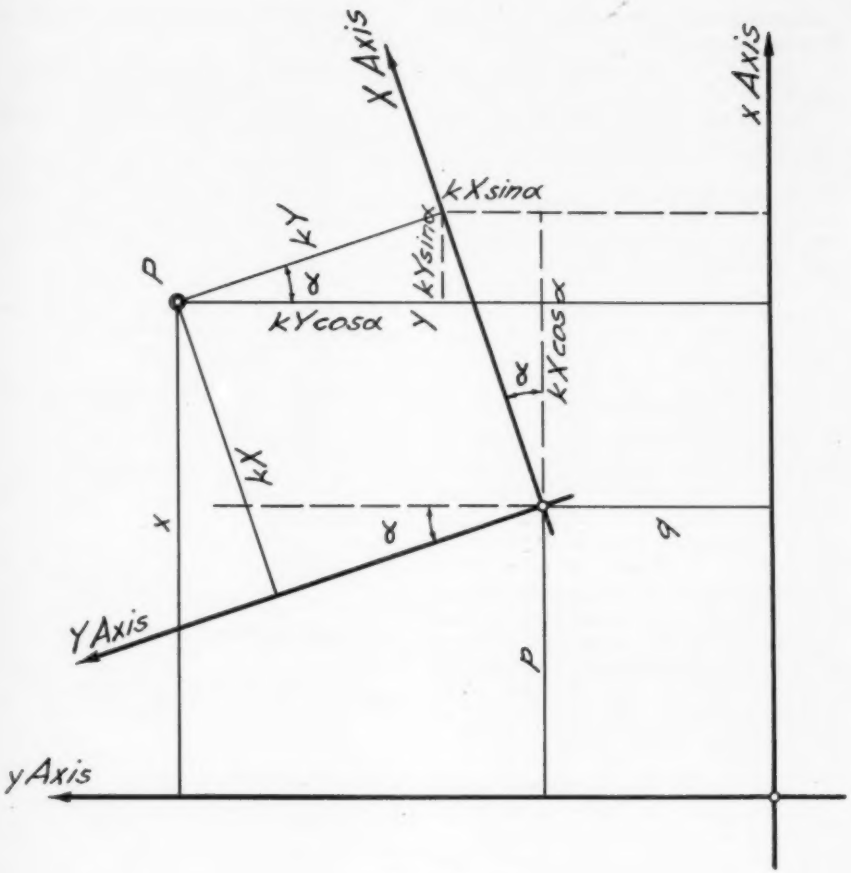

FIGURE 1.

and substituting from formula (4):

$$S = v_{1x}^2 + v_{1y}^2 + v_{2x}^2 + v_{2y}^2 + \ldots\ldots + v_{nx}^2 + v_{ny}^2 \quad (6)$$

Expressions composed of the sum of several similar products are simplified by the use of brackets in the following manner:

$$a_1b_1 + a_2b_2 + \ldots\ldots + a_nb_n = [ab]$$

With the use of brackets formulas (5) and (6) can be written in the following manner:

$$S = [v^2] = [v_x^2] + [v_y^2] \quad (7)$$

Substituting from formulas (3a) and (3b) we obtain

$$S = [(x - p - kX\cos\alpha + kY\sin\alpha)^2 + (y - q - kY\cos\alpha - kX\sin\alpha)^2] \quad (8)$$

S will be a minimum if its derivatives with respect to the independent variables p, q, k and α are equal to zero. Differentiating with respect to p we get:

$$\frac{\partial s}{\partial p} = -2p[x - p - kX\cos\alpha + kY\sin\alpha] = 0 \quad (9a)$$

Since p is not equal to zero we can divide by $-2p$ and get:

$$[x] - [p] - k[X]\cos\alpha + k[Y]\sin\alpha = 0 \quad (10a)$$

and

$$[x] - np - k\cos\alpha\,[X] + k\sin\alpha\,[Y] = 0 \quad (11a)$$

from which p can be computed as:

$$p = \frac{[x]}{n} - k\cos\alpha\frac{[X]}{n} + k\sin\alpha\frac{[Y]}{n} \quad (12a)$$

A similar expression can be obtained by differentiating S with respect to q:

$$q = \frac{[y]}{n} - k\cos\alpha\frac{[Y]}{n} - k\sin\alpha\frac{[X]}{n} \quad (12b)$$

The expressions

$$\frac{[x]}{n},\ \frac{[y]}{n},\ \frac{[X]}{n},\ \text{and}\ \frac{[Y]}{n}$$

are the averages of the coordinate values for the n common points in both coordinate systems; in Publication No. 2 they are correctly referred to as the coordinates of the center of gravity. From formulas (12a) and (12b) it can be seen that the center of gravity is the pivotal point for the coordinate conversion. The development of the final conversion formulas can be simplified considerably if the origin of both coordinate systems is shifted to the center of gravity. The resulting coordinate values for point P_r in both coordinate systems will be:

$$x_r' = x_r - \frac{[x]}{n}, \qquad y_r' = y_r - \frac{[y]}{n} \quad (13)$$

and

$$X_r' = X_r - \frac{[X]}{n}, \qquad Y_r' = Y_r - \frac{[Y]}{n} \quad (14)$$

Substituting for p and q in formulas (3a) and (3b) they can be written in the following form:

$$v_{rx} = x_r - \frac{[x]}{n} - k\cos\alpha\left(X_r - \frac{[X]}{n}\right) + k\sin\alpha\left(Y_r - \frac{[Y]}{n}\right) \quad (15a)$$

$$v_{ry} = y_r - \frac{[x]}{n} - k\cos\alpha\left(Y_r - \frac{[Y]}{n}\right) - k\sin\alpha\left(X_r - \frac{[X]}{n}\right) \quad (15b)$$

or finally:

$$v_{rx} = x_r' - k\cos\alpha\,X_r' + k\sin\alpha\,Y_r' \quad (16a)$$

$$v_{ry} = y_r' - k\cos\alpha\,Y_r' - k\sin\alpha\,X_r' \quad (16b)$$

S can now be expressed in terms of x', y', X' and Y':

$$S = [(x' - k\cos\alpha\,X' + k\sin\alpha\,Y')^2 + (y' - k\cos\alpha\,Y' - k\sin\alpha\,X')^2] \quad (17)$$

Differentiating S with respect to k and equating to zero we get:

$$\frac{\partial S}{\partial k} = 2[(x' - k\cos\alpha\,X' + k\sin\alpha\,Y')\,(-\cos\alpha\,X' + \sin\alpha\,Y') + (y' - k\cos\alpha\,Y' - k\sin\alpha\,X')\,(-\cos\alpha\,Y' - \sin\alpha\,X')] = 0 \quad (18)$$

By dividing by 2 and multiplying the expressions in the parentheses this equation can be written in the following form:

$$\begin{aligned} &-[x'X']\cos\alpha + k[X'X']\cos^2\alpha \\ &\quad - k[X'Y']\sin\alpha\cos\alpha + [x'Y']\sin\alpha \\ &\quad - k[X'Y']\sin\alpha\cos\alpha + k[Y'Y']\sin^2\alpha \\ &\quad - [y'Y']\cos\alpha + k[Y'Y']\cos^2\alpha \\ &\quad + k[X'Y']\sin\alpha\cos\alpha - [y'X']\sin\alpha \\ &+ k[X'Y']\sin\alpha\cos\alpha + k[X'X']\sin^2\alpha = 0 \end{aligned} \quad (19)$$

and then

$$\begin{aligned} k\{&[X'X']\cos^2\alpha + [X'X']\sin^2\alpha + [Y'Y']\cos^2\alpha \\ &+ [Y'Y']\sin^2\alpha\} = \cos\alpha\,\{[x'X'] + [y'Y']\} \\ &+ \sin\alpha\,\{[y'X'] - [x'Y']\} \end{aligned} \quad (20)$$

k can be expressed from equation (20) as:

$$k = \frac{\cos\alpha\,\{[x'X'] + [y'Y']\} + \sin\alpha\,\{[y'X'] - [x'Y']\}}{[X'X'] + [Y'Y']} \quad (21)$$

If S as expressed in equation (17) is differentiated with respect to α and the resulting equation simplified in a similar manner the following formulas result:

$$\begin{aligned} \frac{\partial S}{\partial \alpha} = 2[&(x' - k\cos\alpha\,X' + k\sin\alpha\,Y') \\ &(k\sin\alpha\,X' + k\cos\alpha\,Y') + (y' - k\cos\alpha\,Y' \\ &- k\sin\alpha\,X')\,(k\sin\alpha\,Y' \\ &- k\cos\alpha\,X')] = 0 \end{aligned} \quad (22)$$

$$\begin{aligned} &k[x'X']\sin\alpha - k^2[X'X']\sin\alpha\cos\alpha \\ &\quad + k^2[X'Y']\sin^2\alpha + k[x'Y']\cos\alpha \\ &\quad - k^2[X'Y']\cos^2\alpha + k^2[Y'Y']\sin\alpha\cos\alpha \\ &\quad + k[y'Y']\sin\alpha - k^2[Y'Y']\sin\alpha\cos\alpha \\ &\quad - k^2[X'Y']\sin^2\alpha - k[y'X']\cos\alpha \\ &\quad + k^2[X'Y']\cos^2\alpha \\ &\quad + k^2[X'X']\sin\alpha\cos\alpha = 0 \end{aligned} \quad (23)$$

Several parts of this equation cancel each other. Furthermore we can safely divide both sides by k, because it is not equal to zero. The equation assumes this form:

$$\sin\alpha\{[x'X'] + [y'Y']\} + \cos\alpha\{[x'Y'] - [y'X']\} = 0 \quad (24)$$

from which we can get an expression for α:

$$\tan\alpha = \frac{[y'X'] - [x'Y']}{[x'X'] + [y'Y']} \quad (25)$$

Formulas (21) and (25) can be combined in the following manner:

If the following substitutions are used

$$[y'X'] - [x'Y'] = M \quad (26a)$$

$$[x'X'] + [y'Y'] = N \quad (26b)$$

equation (21) becomes:

$$k = \frac{N\cos\alpha + M\sin\alpha}{[X'X'] + [Y'Y']} \quad (27)$$

and equation (25) can then be expressed as:

$$\tan\alpha = \frac{M}{N} \quad (28)$$

From equation (28) expressions for $\sin\alpha$ and $\cos\alpha$ can be formed immediately:

$$\sin\alpha = \frac{M}{\sqrt{M^2 + N^2}} \quad (29a)$$

$$\cos\alpha = \frac{N}{\sqrt{M^2 + N^2}} \quad (29b)$$

Substituting these in equation (27) k can expressed as:

$$k = \frac{\sqrt{M^2 + N^2}}{[X'X'] + [Y'Y']} \quad (30)$$

By multiplying equation (30) with equations (29a) and (29b) we obtain the final equations from which k and α are computed directly.

$$k\sin\alpha = \frac{M}{[X'X'] + [Y'Y']} = \frac{[y'X'] - [x'Y']}{[X'X'] + [Y'Y']} \quad (31a)$$

$$k\cos\alpha = \frac{N}{[X'X'] + [Y'Y']} = \frac{[x'X'] + [y'Y']}{[X'X'] + [Y'Y']} \quad (31b)$$

Though these expressions seem to be complicated, they can be computed easily if all the necessary values are tabulated properly. Since no trignometric functions have to be found and interpolated, and unnecessary quantities like radial distances and radial bearings do not have to be considered, the conversion elements are not only obtained more accurately, but also faster than by using the method explained in Publication No. 2.

Before the conversion formulas can be applied to transfer the new survey control points from the local coordinate system to the established one, a thorough check must be made to see that no mistakes have been made and that the conversion elements p, q, k, and α actually represent the best transformation possible; in other words, the values of the residual discrepancies v_x and v_y must be computed and then combined in check computations to see whether all conditions are met to make the sum of their squares a minimum. Since there are four conversion elements representing four conditions there must also be four equations in which the values v_x and v_y must be checked.

If the expressions for v_x given in formula (3a) are substituted in equation (9a) the resulting formula is:

$$[v_x] = 0 \quad (32a)$$

A similar formula can be developed from equation (3b) and the equation which is obtained by differentiating equation (8) with respect to q and equating it to zero:

$$[v_y] = 0 \quad (32b)$$

Substituting the expressions for v_x and v_y from equations (16a) and (16b) in equations (18) and (22) results in:

$$[v_x(X'\cos\alpha - Y'\sin\alpha) + v_y(Y'\cos\alpha + X'\sin\alpha)] = 0 \quad (33a)$$

and

$$[v_x(Y'\cos\alpha + X'\sin\alpha) - v_y(X'\cos\alpha - Y'\sin\alpha)] = 0 \quad (33b)$$

The expressions $(X'\cos\alpha - Y'\sin\alpha)$ and $(Y'\cos\alpha + X'\sin\alpha)$ can be computed readily. They represent the original point coordinates converted to a grid system parallel with the established system and with its origin in the center of gravity. To avoid additional work it is convenient to use the values x' and y' instead which are approximately the same. Equations (33a) and (33b) are used in the following form:

$$[v_x x' + v_y y'] = 0 \quad (34a)$$

$$[v_x y' - v_y x'] = 0 \quad (34b)$$

The most convenient way to arrange the

computations is to use a table similar to the one shown in the example in figure 3. Broken down into steps this is what has to be done:

(1) List the point coordinates in both grid systems in columns 1 to 4,

(2) Compute the average of each column and record it,

(3) Compute the values X', Y', x' and y' from formulas (13) and (14) and record them in columns 5 to 8,

(4) Compute the numerators and the denominator of the fractions in formulas (31a) and (31b) by accumulative multiplication. This step involves a somewhat unusual calculation and the accumulation of positive and negative products might be confusing to the beginner. It is advisable to repeat each computation to make certain that no error has been made; for the same reason all decimals should be listed though they are not needed for the final result.

(5) Compute $k \sin \alpha$ and $k \cos \alpha$ from formulas (31a) and (31b). Theoretically α can be an angle between 0° and 360° and the *signs* of the sine and the cosine will determine in which quadrant it is. In most cases the local coordinate system can be assumed in such a manner that α is a small positive angle.

(6) Compute p and q from formulas (12a) and (12b). After this step all conversion elements are known and formulas (1a) and (1b) can be written with their numerical coefficients. In the example shown in figure 3, the conversion formulas are:

$$x'' = 4059.259 + 0.9933015X - 0.1141676Y$$

$$y'' = 10125.789 + 0.9933015Y + 0.1141676X$$

Before these formulas can be used to transfer new points from the local to the established grid system, they have to be checked. The following steps should then be taken to accomplish this.

(7) Compute the converted coordinates of the common points x'' and y'' from formulas (1a) and (1b) and list them in columns 9 and 10,

(8) Compute the discrepancies v_x and v_y for each point from columns 3 and 9, 4 and 10, using formulas (3a) and (3b) and list them in columns 11 and 12.

(9) Compute the values $v_x x' + v_y y'$ and $v_x y' - v_y x'$ for each point from columns 7, 8, 11 and 12, using formulas (34a) and (34b) and list them in columns 13 and 14.

(10) Add the values of each column in columns 11, 12, 13 and 14. According to formulas (32a), (32b), (34a), and (34b) each column should add up to zero.

After the correctness of the conversion formulas has been checked, they can be applied to all points in the local system. To guard against mistakes in this step it is advisable to compare bearing and distance between two adjacent points converted to the established grid system with the corresponding values in the local system. In the example given below points I and J (figure 2) are new traverse points coordinated in the local system together with the bearing and distance between them. After applying the angular difference to the bearing and the distance factor to the distance, their relative positions in the established system can readily be checked.

Local coordinate system:		
Point I	2710.17	2063.91
Point J	2861.95	2359.18
N27°12′18″E 332.00′	+151.78	+295.27
Established coordinate system:		
Point I	6515.64	12485.29
Point J	6632.70	12795.91
N20°38′54″E 331.95′	+117.06	+310.62

Publication No. 2 describes and recommends a secondary correction which has to be applied to each point after its coordinates in the established system have been found by the use of the conversion formulas. This may be necessary in a case where a survey of the size of the City of Balitmore is transferred from one system to the other. Few surveyors will have any occasion to apply conversion formulas over such a large area. It can safely be assumed that for surveys within the range ordinarily dealt with by land surveyors the secondary corrections can be disregarded.

It does not have to be emphasized that coordinate conversion can be applied not only in cases where a new survey has to be tied into an older one, but also in a number of other problems of similar nature which are familiar to every land surveyor. In

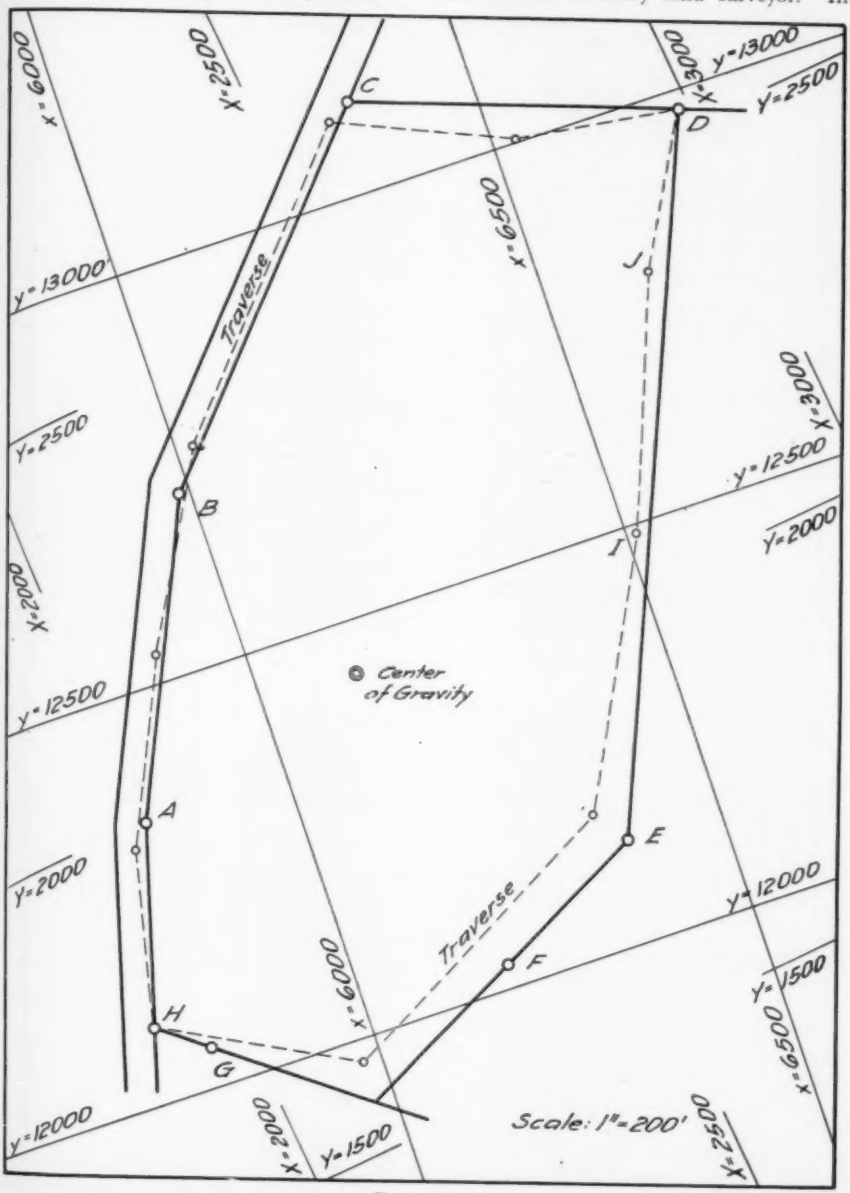

FIGURE 2.

every case the method and formulas described in this article will solve the problem quickly and accurately.

	1	2	3	4	5	6	7	8
Pt.	X	Y	x	x	X'	Y'	x'	x'
A	2000.00	2000.00	5817.54	12340.67	- 315.471	- 55.271	- 307.034	- 90.975
B	2212.64	2353.61	5988.31	12716.39	- 102.831	+ 298.339	- 136.264	+ 284.745
C	2611.87	2711.97	6344.12	13117.67	+ 296.399	+ 656.699	+ 219.546	+ 686.025
D	2985.42	2524.12	6736.39	12974.01	+ 669.949	+ 468.849	+ 611.816	+ 542.365
E	2535.31	1725.17	6380.47	12128.71	+ 219.839	- 330.101	+ 255.896	- 302.935
F	2332.15	1649.85	6187.56	12030.66	+ 16.679	- 405.421	+ 62.986	- 400.985
G	1951.57	1711.72	5802.24	12048.91	- 363.901	- 343.551	- 322.334	- 382.735
H	1894.81	1765.73	5739.96	12096.14	- 420.661	- 289.541	- 384.614	- 335.505
	$\frac{\Sigma X}{n}$ = 2315.471	$\frac{\Sigma Y}{n}$ = 2055.271	$\frac{\Sigma x}{n}$ = 6124.574	$\frac{\Sigma y}{n}$ = 12431.645	+ 0.002	+ 0.002	- 0.002	0.000

Pt.	9 x''	10 y''	11 v_x	12 v_y	13 $v_x \cdot x' + v_y \cdot y'$	14 $v_y \cdot y' - v_x \cdot x'$
A	5817.53	12340.73	+ 0.01	- 0.06	+ 2.4	- 19.3
B	5988.37	12716.25	- 0.06	+ 0.14	+ 48.0	+ 2.0
C	6344.01	13117.78	+ 0.11	- 0.11	- 51.3	+ 99.6
D	6736.51	12973.84	- 0.12	+ 0.17	+ 18.7	- 169.1
E	6380.63	12128.85	- 0.16	- 0.14	+ 1.5	+ 84.3
F	6187.43	12030.84	+ 0.13	- 0.18	+ 80.4	- 40.8
G	5802.33	12048.85	- 0.09	+ 0.06	+ 6.0	+ 53.8
H	5739.79	12096.02	+ 0.17	+ 0.12	- 105.6	- 10.9
			- 0.01	0.00	+ 0.1	- 0.4

$\Sigma y'X'J - \Sigma x'Y'J = + 253\,805.449\,498$

$\Sigma x'X'J + \Sigma y'Y'J = + 2\,208\,203.826\,112$

$[X'X'] + [Y'Y'] = + 2\,223\,095.327\,376$

$k \sin\alpha = +0.114\,1676$

$k \cos\alpha = +0.993\,3015$

$\alpha = +6°33'24''$

$k = 0.999\,8410$

Center of Gravity:

$X = 2315.471$

$Y = 2055.271$

$x = 6124.574$

$y = 12431.645$

$x' = +4059.259 + 0.993\,3015X - 0.114\,1676Y$

$y' = +10125.789 + 0.993\,3015Y + 0.114\,1676X$

FIGURE 3.

Professional Status of Surveyors and Mappers

(Education Division Meeting)

CHAIRMAN WEEDEN: Good morning ladies and gentlemen. Welcome to the 1956 Consecutive Meetings of the American Congress on Surveying and Mapping and the American Society of Photogrammetry. Just to make sure that you are in the right place; this is the Education Division and this morning we are slated for a discussion on the professional aspects of surveying and mapping.

THE SPEAKERS—EDUCATION DIVISION MEETING

Left to Right: Prof. Francis H. Moffitt, George D. Whitmore, Prof. Harmer A. Weeden, Alfred O. Quinn, and Brother Austin Barry.

At the very beginning of the program, I want to acknowledge our indebtedness to Brother Austin Barry, who has done excellent work in organizing and helping to set up this meeting. As I assume the responsibility of the Chairmanship of the Education Division, I do so in humility, for I have seen the great amount of work that went into the preparation and planning of this meeting.

I think that you would not be greatly misled if you were to judge the amount of work that goes into the corresponding and arranging for this sort of thing by the thickness of this folder in front of Brother Austin.

We have a group of educators present this morning who will be interested in getting together here at the speakers table at the close of this meeting to arrange for a luncheon, if we can work it out, so that we can discuss the possibilities of a 1957 Summer Conference for Surveying Teachers. There are quite a few people here who would be interested in this type of a get-together. Dan Harkness, Secretary of the Committee, has been doing some preliminary work, and he would like to get together a group of educators who would be able to contribute constructively to the planning of this type of an affair. So, if you will convene here at the speakers table at the end of this meeting we will make some arrangement to discuss this further at the noon hour.

Now, for the business of the morning—The Professional Status of Surveyors and Mappers. This is a subject which was discussed at the annual meeting of the American Society of Civil Engineers in New York, at which members of our speaking group this morning were present and participated.

Our plan this morning is to lead into the paper by Professor Moffitt in a manner which will perhaps brief some of those in our audience who are not acquainted with the previous work which has been done. I

hope that you were able to obtain a copy of the brief outline on the classification of positions in surveying and mapping.

Brother Austin Barry, who has been the Chairman of this Task Committee of ASCE, and who has done a good bit of the spade work with Al Quinn and George Whitmore, will start the discussion from the point of view of the work done; Al Quinn will speak from the point of view of a man engaged in surveying and mapping in the professional field and give the industrialist's point of view; and George Whitmore will speak from the point of view of a professional man related to the Government.

So, at this point, I will turn the discussion over to Brother Austin, who will introduce us to this rather important subject.

BROTHER AUSTIN BARRY: Thank you, Mr. Chairman. Ladies and gentlemen: I will try to go over this rather rapidly and acquaint you with our work in the ASCE Task Committee as best I can in the necessarily limited time. Consequently, if you miss anything, if there are any gaps in your knowledge and appreciation of what has been going on, you are perfectly free to ask questions and to fill in those gaps.

In 1953, the Surveying and Mapping Division of ASCE was asked by the Board of Direction to study the activities of its membership; to classify various operations of surveying and mapping as to professional, sub-professional and non-professional; and give it considerable deliberation. The Executive Committee, in October of 1954, appointed the present Task Committee to work on this problem. It was also to investigate the relative question as to whether all the professional activities in surveying and mapping should be recognized as civil engineering or a field apart from civil engineering.

This report was put out in bulletin form and was presented at the ASCE meeting in New York, October 24, 1955. While it is not possible for us to give each of you a copy of the large report, we did, however, print the classification outline, and, on the back of it, we excerpted a few of the more important items that appear in the report and will serve to explain it.

The sheet available here is a skeleton of this larger Task Committee Report. Parenthetically, I may say that the report has been printed[1] and members of ASCE will receive it automatically by having stated their membership in the Surveying and Mapping Division, or may receive it, if not members of that Division, through request to ASCE on the coupon printed in the *Civil Engineering*.

What has this task force done? To date, we have, we believe, analyzed and classified all surveying and mapping activities as we know them in the United States. If you look at the outline, you will discover there are six such categories or classifications: Land Surveying; Engineering Surveys for Design and Construction; Geodetic Surveying, which might be called Geodetic Engineering or Geodesy; Cartographic Surveying or Cartographic Engineering or Map and Chart Surveying; Aerial Survey Services; and Cartography.

Within each of those, we have shown on the basis of our definitions of professional- or technician-level work, who may properly be thought of as being either professional or technician. You will notice in category I, for example, we say that the Land Surveyor should be considered a professional man and all these other men, Instrumentman, Computer, Draftsman, Tapeman, Rodman, and so on, would be pre-professional or technician-level workers.

At the moment, no attempt has been made to determine or ascertain whether any or all of these be engineering or not engineering. It is the continuing work of our Task Committee to study that particular question. Anything that we may say now does not represent a considered opinion and is not something that could not be changed by further thinking.

Obviously, publication of this report in its present form will, we hope, elicit opinion from all of you and from others to corroborate or to contradict, as the case may be. But, we believe that it has been a necessary

[1] *Journal of the Surveying and Mapping Division*, Proceedings of the Am. Soc. of Civil Engineers, No. SU 1, March 1956.

task, and we shall continue to refine this part of the report and also continue the study of just what should be considered engineering among those groupings and what should not be.

The three tenets, as we call them, the professional level, technician level, and pre-professional level were defined. Essentially then, professional work was considered to be work performed by a person involving the exercise of professional judgment, frequently based on knowledge acquired through higher learning, and generally non-routine in character. The term implies one who can plan, perform, and/or direct all such operations in the category. Technician-level work is primarily routine, of a technical nature, often demanding a higher degree of skill, done under the direction of a professional person who is responsible for its outcome. Pre-professional level is work at the technician level performed by a professional trainee who, having completed courses of specialized intellectual instruction and study, is seeking to attain professional status.

Each of the following definitions, which I shall not read, indicates what is meant on the outline by such terms as Geodetic Surveyor, Control Surveyor, Survey Engineer, Topographer, and so on. You will notice a couple of them are standard terms and a couple have been coined more or less for the operation, such as the terms Surveying Engineer, which is not as widespread a term in the United States as it may be elsewhere, and Control Surveyor, which is somehow not as usual as it might be expected to be.

I would like to point out that, as a result of the study reported here, it has become apparent to those of us who are working on it, that it is no longer possible for us, with any degree of abandonment, to say "surveyor." I would like to clarify that point because I believe it is important.

The tendency in the past to lump all surveying activity in one general "glob" and speak of "surveying" as though it could be summarily consigned to a special profession or to a subsidiary realm somewhere beneath the more glamorous Civil Engineering title must now be recognized as impossible.

There is not simply a "surveyor," but there are land surveyors, engineering surveyors or survey engineers, geodetic surveyors or engineers, and mapping surveyors or mapping engineers, just as there are sanitary engineers, structural engineers, hydraulic engineers, and foundations engineers within the Civil Engineering fold.

I say that because when people talk of surveying, by and large, they tend to think of something which their audience may not think of. If you meet a land surveyor and he says "surveying," he means land surveying. If he is talking to a man who is concerned primarily with control for cartography or mapping, he may presumably not get his ideas across. Personally, I believe that this has been a considerable obstacle in the past in trying to meet on common ground.

While speaking in this manner of "survey engineers" or "land surveyors" it must be admitted that one can easily beg the question and prejudge, by one's very language, that the two are separate professions. It is not the desire here and now to do so, although it is the current task of our committee to ascertain the proper classification of these and the other four categories in our outline.

Some have asked what value may result from this delving. Some are content to let the matter rest and not stir the waters less they become muddy. However, our belief is that clarification will result from the study.

The study was precipitated by some lack of understanding and some lack of clarity. In fact, even those who determined that such a study should be made, including the three of us who did the delving, were not at all convinced when it was begun, that it would result in anything worthwhile. We, however, believe that it has done something to clarify the whole status of surveying and mapping. To recognize, for example, that a given job may be performed, and perhaps performed better by a technician, is to find a dozen or more engineers who can be better placed at more demanding work. We, with the clarity that typifies our professional

thinking, must give others the opportunity to help us do the job which we say or some say there are too few of us to do now. I do not believe we shall do aught but enhance the prestige of the profession by working as a tripartite team: professional, technician, and skilled craftsman.

I have added a note on the bottom of the sheet regarding photogrammetry. This note has puzzled a few but I believe that it is rather easy to agree that photogrammetry is not to be listed as a particular category of surveying, but rather as an important, extensive, and invaluable technique used in many branches of surveying work. The listing of aerial survey services as a special category does not intend that all or even the most important uses of photogrammetry are included. Attention is called by footnotes to other major employment of this technique in almost all the other categories. Similarly, electronic measuring techniques, despite their newness, are given their proper place in whatever they serve.

I would like to say for the moment that I will stop now, being assured by the Chairman that I will be able to add anything later, if I need to. Thank you.

CHAIRMAN WEEDEN: Thank you, Brother Austin.

To further enlighten us in the introductory phases of this, we will now hear from Alfred O. Quinn, better known to his friends as "Al Quinn," who is with the Aero Service Corporation. He will speak to us from the point of view of a professional man in the business of surveying and mapping.

MR. QUINN: Mr. Chairman, ladies and gentlemen.

As has been stated, our Committee was divided into three different categories: one, the educator; one, the man in the Government, and I am the man who is allegedly to look after affairs from private practice.

I have made a few notes on some of the things which concern the man in private practice in the field of surveying and mapping. I think you are all reasonably well aware that the common picture of the surveying and mapping profession is probably best exemplified at the present time by the old poke who is out with a rickety old transit, wearing old ragged clothes. I think you have all seen that particular cartoon and I am afraid that many people who are concerned with surveying and mapping problems as potential clients of ours, have the general impression that that is the way surveying and mapping is done at the present time.

Of course, those of us who are here at this meeting know that is not true, but, nevertheless, I think one of the fundamental tenets from which we must do our thinking is that the general public thinks of the surveyor as an oldtimer, with a cud of tobacco and all that sort of thing, doing rather quasi-accurate work and, certainly, in no way living up to our hopeful impression of him as a professional representative of our industry. I think we need professional status for several reasons. We need to improve the quality of work that is done in surveying and mapping. We need to have a code of uniform fees by which we can set up standards for charging potential clients. Certainly, the general public needs protection by licensing in the various States to make sure that surveying and mapping is carried on in the highest possible standards. The achievement of professional status involves several things, but basically, in my opinion, it involves education and understanding by the potential users of surveying and mapping, both governmental and private, by those who are practising in the profession of surveying and mapping, and by educators who are charged with the responsibility of bringing to the industry, thoroughly trained and thoroughly educated men and women.

The Committee Report is designed to categorize the various phases of surveying and mapping, as we see them. It has certainly prompted discussions, and it has attempted to review the basic problems of the status of the surveyor and mapper in terms of his professional status. As Brother Austin Barry has stated, eventually, we hope to study the problem of the engineering status of the various facets of surveying and mapping. The Committee Report has brought before the American Society of Civil Engineers, a professional society, the problem of

the place of surveying and mapping in that organization and, in final form, we expect and hope that the Committee Report will be placed in the hands of the various State licensing boards throughout the United States to assist them in determining the status of surveying and mapping as to whether or not it should be licensed within their States.

The results that we hope may come from these deliberations of ours are, first, a fundamental definition of the activities in surveying and mapping; second, definitive licensing in the various States; third, the establishment of a general fee structure which will govern operations in surveying and mapping; fourth, the award of surveying and mapping work on a professional, that is, a nonbidding basis; and, finally, we feel that this report should bring about higher standards in our profession of surveying and mapping. It should attract the better students into colleges to pursue surveying and mapping, and we feel that if these things are accomplished we will increase the sound basis for further research and development in the field of surveying and mapping.

With these remarks, I will stop temporarily, with the idea that a little later we can discuss further some of the points which I have raised and consider, perhaps more thoroughly, the place of the private practitioner of surveying and mapping in this whole very interesting field. Thank you very much.

CHAIRMAN WEEDEN: Thank you, Al.

The third of our introductory speakers, who will, as I have mentioned before, approach this subject from the point of view of a man connected with the Government, is George Whitmore. He is with the United States Geological Survey.

MR. WHITMORE: As the governmental representative on this 3-man Task Committee of ASCE, I have been asked to present briefly my views on the probable effect on governmental surveying and mapping agencies if the proposals in the Committee's first-phase report find wide acceptance.

Will Government accept the ASCE plan?

First we should probably ask, and try to answer, the question of whether the proposals of this report are likely to find ready acceptance by the Government surveying and mapping agencies. Also, and perhaps even more important, will certain key members of the Civil Service Commission find the proposals to their liking.

Although I am usually a pessimist in a situation of this kind, in this instance I am inclined to be optimistic. I have a feeling that most of the Government surveying and mapping agencies will find, after careful study, that the setup proposed by the ASCE Committee can be advantageously adapted to their organizations. I am even naive enough to hope that most of the agencies might support it with some enthusiasm.

I feel also that there is reason to hope that the Civil Service Commission would find it suitable for their purposes, considering the trouble they have had in the past in formulating an acceptable set of standards and qualifications for surveying and mapping positions. I will be quite optimistic about this if it happens that a majority of the Government agencies find that they can endorse the ASCE plan.

How will the ASCE plan affect the status quo in Government agencies?

Although I am not too well informed on the fine points of the organizational plan of many of the Government's mapping agencies, I have the impression that the ASCE plan could be adopted by most of them without having to make any really serious adjustments in organization. That may be true, for example, for such agencies as the Army Map Service, the Hydrographic Office, the Coast and Geodetic Survey, and the Aeronautical Chart and Information Center. Certain other organizations would have to make significant changes in their organizational plan, assignment of duties, recruiting practices, etc. Notably among these latter would be my own organization, the Topographic Division of the U. S. Geological Survey.

The Survey traditionally has employed and utilized graduate engineers, or persons having equivalent training, for the majority of the so-called journeymen positions in field

surveys and photogrammetry. After persons of this caliber become well trained, they need very little technical supervision so that in the next level above the journeyman producer, which is Grade 11 in Government parlance, there are relatively few openings, and advancement into that grade depends upon the slow process of attrition except during time of expansion.

Obviously, if the Survey were to approve the ASCE concept, a rather significant change in policy would have to be made. That is, the majority of the journeyman employees would be technicians who would be trained in only one or two specialized operations, and who would not be expected to exercise professional judgment. This in turn would require a greater number of the professional-level supervisors in order to accomplish the work economically and to the proper standards. Thus, under this plan a relatively small number of pre-professional junior engineers or equivalent would be employed each year, but their opportunities for steady forward progress into the full professional grades would be much better. They would be given an intensive training course during the first few years of their employment, during which time, as a part of their pre-professional training, they would often be doing the same work as the technicians. At the end of the training period, assuming normal behavior and at least average ability, they would be more or less automatically graduated into the lowest full professional grade, GS-11.

In the case of the Geological Survey and certain other agencies, the changes that would be required would create some rather serious adjustment problems in the beginning. In spite of this, however, I am quite confident that the Survey would go along with this plan, especially if it were found acceptable to other agencies and the Civil Service Commission.

What steps are necessary to bring about such changes in the Government agencies?

This is a good question and frankly I don't know the answer. I would suggest, as a first step, that ASCE members or other key people in each surveying and mapping agency make it a point to obtain copies of the ASCE report and to study carefully its proposals and possible ramifications. At any convenient time after that the ASCE Committee, or other appropriate representatives of ASCE, would be glad to meet informally with representatives of Government agencies for the purpose of exchanging views and suggesting steps that might be taken to initiate official Government consideration of the ASCE proposal.

It would also be helpful if ASCE members who are employed by the Government mapping agencies, or non-members who are key officials in those agencies, would contribute discussion papers to ASCE for publication in the ASCE's new Journal of the Surveying and Mapping Division.

As a first step, then, we urge our associates to study the report, consider its ramifications, contribute to the formal published discussions, and later to organize an informal discussion group to determine whether joint action by all agencies would be feasible or desirable.

In this connection, it is well to bear in mind that one of the principal points to be determined is whether to push for action on the basis of this first-phase report (which mainly defines the field of surveying and mapping and recommends dividing lines between professional and technician duties), or to wait for another year or so in the hope that ASCE would by then have taken a position on the related question as to which activities are in the engineering field.

CHAIRMAN WEEDEN: Thank you, Mr. Whitmore.

We have had the nature of the problem described. For a critical review of it, we have the privilege of hearing from Professor Frank Moffitt from the University of California, who will present his points of view with the hope that they will stimulate further discussion.

Professor Moffitt is well qualified to do this in that he is directly concerned with the setting up of curricula, not only for students who are studying at the University of California, but also for surveyors and mappers who are interested in doing work under extension. He is active in the work of the American Society of Photogrammetry, as

well as our own Congress of Surveying and Mapping, and is also youthful and energetic, which, I think, is a qualification which is important in this case as well.

PROF. MOFFITT: This discussion will begin with a few examples of what a good many of the general public consider to be the professional status of surveyors and mappers. In the last four years, since I have been in charge of the surveying program at the University of California, I have received at the latest count twenty-nine letters from people in Northern California requesting that I arrange for students to do some sort of surveying or mapping for them, so that the students might get some experience. A few of these people mention that they would be willing to pay for such work, but, for the most part, the people feel that the experience the students would derive would more than compensate for any pay, which may in some cases be true.

In the same four years, I have received nine letters from the general public asking me for information about how they can make their own survey, what books they can read, where they can get hold of the instruments they will need, and so on. These letters are in addition to similar requests made by telephone for which I do not have a count.

I know that this is not unique to Northern California. Those of you educators to whom I am speaking now, who are engaged in teaching surveying, can go back through your own correspondence files and find the same thing. If all such letters and requests were summed up it would make an impressive figure, rather, an appalling figure as far as we are concerned. Nevertheless, let us not kid ourselves, if the reason for our desire for professional status is to enhance our standing in society, then the public decides who is or who is not of so-called professional stature. Now I honestly don't know what other deep-seated motive there is for a man who is legally practicing surveying and mapping to desire professional status. By legally practicing, I mean a person registered in his state to practice surveying and mapping under the law. The case of the person who is not registered is in my mind an altogether different thing. I know, from my own experience and from the experiences of my colleagues on the West Coast, that this business of becoming registered can be most aggravating. It is always in the back of our minds, nagging at us continuously. As most of you know, teaching such things as civil engineering and surveying in California is not practicing what we preach, and, as a result, our experience which we accrue in teaching does not apply toward registration. Going back to the non-registered person, his motive for wanting professional recognition is dictated by urgency. His motive is a matter of convincing a board of examination that the work he engages in is worthy of recognition by the board.

This brings me to the report entitled, "Professional Aspects of Surveying and Mapping" prepared by the task committee of the Surveying and Mapping Division, American Society of Civil Engineers.[1] This report, so far as I am concerned, is monumental. I have never before seen such a thorough treatment of the definition of the words "professional" and "profession." It is the first of two major goals of this committee. It defines the boundary between professional and technical work in surveying and mapping, and also the boundary between professional and pre-professional work. As you can well imagine, this is a difficult task to say the least. The second of the committee's objectives is to attempt to determine "whether all the professional activities in surveying and mapping should be recognized as civil engineering, or as a field of science apart from civil engineering." This phase is still forthcoming. Now the boundary between a professional and a technical activity in this field is highly flexible, sometimes very wide and sometimes a thin line. To quote the report, in the chart classifying various positions in surveying and mapping, under "II Engineering Surveys for Design and Construction we find A. Design Data Surveys (including Route Surveys) 1. Control, horizontal and vertical, 2. Culture and Topography, 3. Profiles and cross sections; B. Construction Surveys 1. Lay-out Surveys, 2. Quantity and Measure-

ment Surveys, 3. 'As-Built' Surveys, 3a. Utility Surveys; and C. Mine Surveys." This work is performed at the professional level by the "Survey Engineer." Under the "Technician or Pre-professional Level" are listed "Instrumentman, Computer, Draftsman, Tapeman, Rodman." The report gives a definition of "Survey Engineer" as found in ASCE Manual No. 34," Definitions of Surveying, Mapping and Related Terms" 1954, but altered somewhat for clarity. "Survey Engineer—obtains information for planning or developing an engineering project and estimating its cost, often recording such information in form of an engineering map or plat." By this definition, the survey engineer obtains information by making surveying measurements, often compiling maps to show more clearly such measurements. Now who does this, the survey engineer or the instrumentmen, computers, draftsmen, tapemen and rodmen? The report is not clear on this point. Certainly the survey engineer cannot do it all by himself, and if he does any of it, he must be either an instrumentman, a computer, a draftsman, a tapeman, or a rodman. Perhaps at times he performs one duty and at other times another duty. If he does not engage in any of the actual physical doing of the work, then he becomes a director, or a supervisor, and if this is the situation then the report should define a survey engineer as a person who only supervises the obtaining of information and so on.

To go farther, assume a situation where a chief of party is sent out by an engineering firm to a particular area to obtain data in the form of a topographic map. His immediate superior does not accompany him. Therefore, the planning of control, searching the records for boundaries and monuments, acquiring personnel, and the execution of the topographic map are all a part of his assignment. This is in turn subject to the approval of his superior, and as soon as the superior indicates approval, he, the superior, immediately assumes responsibility for the entire work. Now in this situation, who has acted in a professional capacity and who in a technical capacity? If the superior has acted in the professional capacity by virtue of assuming responsibility, then the report under discussion should define the survey engineer as a person who is responsible for the information obtained and so on. In the above situation, the person assuming responsibility, had nothing to do with supervising or directing the operation. It seems to me that up to the point of approval by a superior, the chief of party has acted in a professional capacity since it was his judgment, knowledge, discretion, intelligence, personal contact, and so on which enabled him to perform the work.

The report does not discuss the possibility that the professional person does at times act in a purely technical manner. Certainly in the business of land surveying, the land surveyor spends a great deal of his time in doing as well as thinking. Imagine a land surveyor trying to form an opinion concerning a certain tricky boundary problem, whereby he can advise his client, without having tramped around making on-the-spot observations and measurements together with some routine calculations. This also applies to the other types of professional-level titles as given in the ASCE committee's report. By the very nature of surveying and mapping, quite a bit of physical work is required, this being technical and specialized for the most part. Or imagine how much dental work would get done if the dentist simply sat and cogitated and didn't do any physical work. By the way, my impression is that the public-at-large considers a dentist as being a professional man. Now it is true that there is a small percentage of men engaged in surveying and mapping purely in a supervisory capacity who shoulder quite a bit of the responsibility for getting the work performed; a few in a purely executive capacity who decide policy and things of that sort; and a few in a planning and advisory capacity who consider such things as the techniques to be applied, the economics of the job and so on. These men may never turn an angle, stretch a tape, or sketch a contour line. At the other end, there is a large percentage of men engaged in nothing but the technical and instrumental part of the job, who shoulder just enough responsibility to do satisfactory

work in order to maintain their job. But in between these two, we must consider the surveyor or mapper who includes both these phases in his everyday operation. The report does not point this out except that in the definitions of the various professional positions, almost each definition begins with the words, "plans, performs or supervises." Perhaps in the definitions themselves lies the flexibility which I believe is essential to the report.

The last criticism I have to make of the report pertains to the handling of photogrammetry not as a major branch of surveying and mapping, but rather as an important, extensive and invaluable technique that is used in many branches of the work. Personally, I believe this handling of photogrammetry is very wise, and I wish to commend the committee on this. It has found favor with everyone with whom I have discussed the report. My criticism lies in what seems to be an omission following the statement "To single out this technique for special treatment as a branch of surveying, rather than as a tool is likely to result in less than wholesome and just registration laws." I believe that this statement should be followed by an amplification of the statement—to state the reasons for it being likely to result in less than wholesome and just registration laws. Frankly, I have an extremely difficult time keeping an open mind on this subject, with photogrammetrists on one side and civil engineers and land surveyors on the other side.

Now for comments in favor of the ASCE report. The committee has taken perhaps the most unpleasant and the most controversial problems to face a committee and has done a splendid piece of work. I say unpleasant because the nature of the task hits the individual personally. It is human nature for a person to want professional recognition. Herein lies the reason for some of the trouble in which we found ourselves in California when the Northern California Section, American Society of Photogrammetry attempted to advise the Senate committee on matters relating to registration of photogrammetrists. The matter hit the membership personally, and I do not believe we handled it wisely. The ASCE committee has met the task squarely without pulling any punches.

The immediate effect of the report has been to alert societies other than the American Society of Civil Engineers, to force action in these other societies—action which will still further help to clarify professional status of surveyors and mappers.

The immediate benefit of the report will be to put into the hands of the various State boards of engineering examiners a concrete guide to help evaluate a man's experience in the field of surveying and mapping. If it is adopted by the American Society of Civil Engineers, it will carry considerable weight with the State examining boards. The second phase of this Task Committee's work will still further assist the work of the State boards.

The report will benefit the members of the Education Division of the Congress in three ways. First, it will help the members who are engaged in teaching or who are responsible for the teaching of surveying and mapping to review their own program of instruction in the light of the report with the purpose of improving and strengthening their program. Second, it will serve as a guide to teachers who are advising students interested in the field of surveying and mapping and in related fields. Third, the report will help to bolster the arguments we put up when fighting to hold the line on instruction in this field.

Leaving the ASCE report, I will discuss a few things about surveying and mapping which seem to offer resistance to the attainment of a professional status in the eyes of the public and in the eyes of our associates.

At a session on boundary surveys conducted by Mr. Wattles, our National Vice President, as an extension course at the University of California, he was discussing some of the things that a land surveyor owes to his client as a professional practitioner. One hundred forty men were present at this session. One of the things the surveyor should do is to perhaps spend a little more time and money on a particular survey than will be covered by the client rather than spend just so much time and then no more.

A great roar came up, indicating to me that either some of the members present thought that such a suggestion was ridiculous, or else that their own observations of the way a land surveyor operates are contrary to Mr. Wattles' advice. Now this does not speak well for land surveyors.

Being interested in the advancement of the State plane-coordinate systems, I have read, over the past five or six years, articles in the Journal pertaining to discussions of the State systems. One frequent complaint found in these articles or in comments on these discussions is that control for establishing a survey on a State coordinate system is too far away and the added expense of bringing in the control is too much. Bringing up a complaint like that is not acting in a professional manner.

In the majority of civil engineering undertakings, the execution of a survey or the production of a map are but a part of the undertaking. Many small surveys can be handled by a small engineering firm without too much trouble, and many engineering firms have no need for outside help. In a situation like this, the survey end of the undertaking is not looked upon as being professional activity. The fact that a small percentage of engineering firms call in specialists when the survey is beyond the capacity of the firm is not realized by the numerous other firms. Here we have a large number who consider the surveys they require as being sub-professional, while a small number recognize the service they obtain as being professional service. This large number reflects unfavorably on the whole surveying and mapping field. You sense this idea among educators, even among members of your own faculty when discussing surveying and mapping in your own curriculum.

The absence of standard fees for surveying and mapping services presents a stumbling block to professional status in the eyes of the general public and other engineers. Standard fees have been suggested from time to time, but I do not believe they have been generally adopted except where surveyors and engineers have organized as an area-wide group. Several of these organizations have come into being in the past five years much to the benefit of the profession, but in general, standard fees are rather loosely applied. This shows up in the variation in fees charged for performing photogrammetric mapping. I have examined at least three fair-sized mapping projects where the lowest bid, if you will pardon the expression, was one-third of the highest bid or less. This, of course, results from competitive bidding and should not be taken as reflecting a disparity between various charges for a given mapping project which would result from negotiation.

This reference to bidding vs. negotiation introduces still another difficulty facing surveyors and mappers when trying to improve professional status in this field. This difficulty is at the very roots of the trouble we are experiencing in California in our registration problem. On the one hand, direct negotiation between a responsbile firm and the client would appear to be more professional; yet, on the other hand, competitive bidding, where the bids are received from firms with a reputation for reliability and integrity, can result in good surveying and mapping at a substantial saving of money by virtue of the competition. At the annual meeting of the Congress last March, Mr. Michael Baker, a registered engineer and a member of the Pennsylvania State Registration Board, gave a most stimulating presentation of this matter. His contribution to the panel discussion "Reappraisal of Relationships Between Surveying, Photogrammetry, and Engineering" appears in SURVEYING AND MAPPING, Vol. XV, No. 2, page 158. I recommend this discussion to you. Until such time as bids for surveying and mapping services begin to compare one with another, and until such time as work performed by low bidders is found to be of inferior quality, I feel that clients, especially when the clients are public-works organizations, are going to continue to ask for bids.

The final thing which I wish to discuss that seems to offer resistance to the attainment of professional status for surveyors in the eyes of the public-at-large is collective bargaining. This is the year 1956; collective bargaining is legal; it is well protected

by Federal and State laws; and it is perhaps the most priceless protection we in the United States have to maintain our economic well-being. Collective bargaining will be around for quite awhile. Much surveying is done by surveyors who are a part of organized labor. By collective bargaining, they have gotten very good wages for their skills. Collective bargaining seems to carry with it the label "nonprofessional occupation" because the labor laws handle professional and nonprofessional occupations differently. This reflects on the entire surveying profession.

The final topic of this paper is in the form of suggestions as to some ways in which the colleges can help to improve the status of surveyors and mappers.

The first suggestion is to implement the resolution of the Education Division made here last March. "Resolved, that the American Congress on Surveying and Mapping encourage that the teaching of surveying and mapping in the colleges and universities be directed toward the development of mature professional judgment and ability rather than toward the perfection of individual techniques." The way in which this resolution can be implemented is the subject of a full discussion which will take place tomorrow.

Second, the surveying faculty should do all within reason to promote the use of the State plane coordinate system, to explain its operation, to point out its value to the students, both regularly enrolled students and those in organized extension classes.

Third, the surveying faculty should themselves handle outside work in a professional manner. I need not elaborate on this.

Fourth, in replying to requests made by mail or by telephone regarding surveying and mapping or pertaining thereto, the faculty should take this opportunity to explain to a person that he needs the services of a professional surveyor when in fact he does. Much can be conveyed in such a reply.

Fifth, the faculty should cooperate to promote professional courses in surveying, mapping and photogrammetry designed to serve those already in the field and who should be kept abreast of current developments. I am amazed at the eagerness with which men working in the profession study in extension courses. They travel miles to attend these courses if a good program is worked out for them. Witness the enrollment in Mr. Wattles' course being given now. There are about 152 men, some traveling as far as two hundred miles on weekends to get the benefit of this man's experience and wisdom. The man himself travels 900 miles round-trip every other weekend to present his course.

I will close by saying that, since the subject of professionalism is controversial, I have attempted to make my remarks controversial. These views are my own, and I know that several of my comments are in complete disagreement with the views of many of my friends. But, after all, the Congress give us the opportunity to air our own particular views, and I appreciate the opportunity to air mine. Thank you.

CHAIRMAN WEEDEN: Thank you, Frank, for a very complete and able presentation.

We are now going to throw this subject open to discussion from the floor, and I would like to urge you, if you would like to speak, that you come forward. Take this microphone as you come up here and identify yourself, with your affiliation. If you wish to address your remarks to one of the particular members of this group, you may do so. In the absence of directed questions, I will exercise the right to direct the question to a member of the panel, and I hope that this will result in a rather lively discussion. I now throw the subject open to discussion.

BROTHER AUSTIN BARRY: I would like to take time here to pick up something that Prof. Moffitt said and straighten this out. In that term and definition of "surveying engineer," I believe we recognize that there is a lack of clarity that might help the understanding in all of the others. Notice that we say generally that the particular surveyor plans, performs, or supervises such an operation. Here apparently we could do the same thing because it was the intent to do so, and in "surveying engineer," we could say: "Survey Engineer—plans, performs, or

supervises surveys to obtain information," et cetera.

That may straighten out a little of the misapprehension you may have had. Tied in with that is the question: Does a professional man need to sit back in an office chair and merely direct the work from a distance or with white gloves for fear he may touch some contaminated instrument? I know you recognize that is not the case, but to the extent that a man does plan or direct a survey he is engaging in professional work, even though he does some of the operations.

There is a need to rise to the defense of the teachers and to say that we believe that teaching civil engineering or any type of professional course is certainly the equivalent of and should be regarded as the professional work itself. That is so regarded in such states as New York, New Jersey, and others that I know of, and in professional societies, such as ASCE.

CHAIRMAN WEEDEN: Do you wish to bat this around any, Frank?

PROF. MOFFITT: No, but I want to ask one of the members of the Committee to elaborate a little bit on why the registration of photogrammetrists would perhaps result in unjust registration laws.

CHAIRMAN WEEDEN: Al?

MR. QUINN: I will take that one. The question with regard to registration of photogrammetrists has, as Prof. Moffitt has indicated, been raised in the State of California in a rather serious fashion. The thinking of the Committee, and believe me we have discussed this particular facet to some little degree, has been that photogrammetry, as we show in our definition here, is a tool, a means to an end in the surveying and mapping profession.

We do not believe that basically photogrammetry can be completely severed from surveying and mapping and made a science or a separate entity in itself. We think, for example, that the trend of the times may be such that the next 20 years will see substantial changes in our means to an end in the matter of surveying and mapping, and it is quite likely that photogrammetry, as we know it today, may be replaced, modified, or in some way changed, so that any registration pertaining to the status of the science of photogrammetry as of now might well be changed in the not too distant future. I am thinking of the development of electronic devices for measuring distances, the electronic method of actually plotting from photographs, and so forth.

PROF. MOFFITT: I would like to elaborate a little bit on what was going on in California. You will recall from one of the remarks in this discussion I had about the business of professionalism hitting and striking closely and personally the American Society of Photogrammetry. The California Section is quite large and there are quite a few of the members of that Section who are in technical-level operations.

We had several meetings when the Senate Interim Committee on licensing businesses and professions was ready to hold their hearings and it seemed as though everybody wanted to get registered because they wanted to obtain professional status. The way they thought they could do it was by being recognized through the State Board of Licensing.

That is what I meant by the thing striking personally. We had several different committees at different times to try to advise the Senate Committee, and, more particularly, the Secretary of the Senate Committee, as to how to set up the change in the licensing laws for civil engineers. It came out in a rather ridiculous fashion that the civil engineers and the land surveyors would have found, had this thing passed, which it didn't fortunately, that they would not have been able to make surveys on the ground. Because of the way it was set up, the photogrammetrists were going to be isolated and they were going to make all their own control surveys. The only thing they were going to be excluded from doing was making boundary surveys.

One of the biggest arguments against that supposition is that any control survey established under the specifications called for in the State of California, especially the Division of Highways, would have second-order accuracy. Subsequent boundary surveys would be made from the control of

the photographs. That was one of the big arguments they had in California.

MR. QUINN: May I make one other statement on that? We do not, as a Committee, advocate necessarily that the present licensing laws nor the present examinations which are given to license people are necessarily correct. Believe me, we haven't gotten into that at all in any specific State. I think the feeling of the three of us is probably that that is something that we are going to have to tackle a little bit later on.

But basically, our idea has been, you might say, to get back to fundamentals and define surveying and mapping and make the data available to the various boards. Then I think it will be incumbent upon our Committee, or perhaps later committees of ASCE should they elect to adopt our findings, to seek to educate the licensing boards a little bit with regard to our profession. I think they will then clear up some of the problems that Prof. Moffitt is bringing up now. But, it is going to take a period of education and general knowledge on the part of the boards so that they can appreciate some of the problems of the surveying and mapping group as a profession in itself.

MR. SHAPIRO: My name is S. E. Shapiro, Associate Professor, University of Illinois. It seems to me that the entire question of professional status is based to a great extent on the fees by which the registered land surveyors are competing against each other. The gentlemen here have brought out the question of professional status in the eyes of the public. In Cook County, I have been in contact with registered professional land surveyors who are competing one against the other in a most ridiculous manner by lowering their fees to a level far below the fees which they charged back in 1936 and '37. From that standpoint, it seems to me, the professional status of the land surveyor is certainly not in any way improved by men competing against each other.

Furthermore, addressing Mr. Whitmore of the USGS, about four years ago up at Great Lakes, the Government was encouraging competition in the way of bids from land surveyors, actually taking the lowest bid. Of course the man has to be registered. But by taking the lowest bid they encouraged the type of thing that the American Society of Civil Engineers has discouraged.

I believe the way to encourage professional status in the eyes of the public is to have some sort of a set rate of fees, some way of establishing fees, so that the public can feel that they are working with professional people instead of just, as they think of it, ordinary workmen.

In Cook County, a great attempt has been made to set up an association of registered land surveyors with the idea of establishing a certain fee for a certain type of work. Of course, the attempt has not had too great success even though they have an organization.

I would like to ask Mr. Whitmore to comment on that.

MR. WHITMORE: I don't doubt but what it is true that all through the Government, there have been many cases where competitive bids for surveying and mapping have been invited. I know we have done it in Geological Survey for certain phases of topography. It is tradition, for one thing, and secondly, there is a feeling that bids of that sort are required by law.

I think one of the things we have got to do to get that interpretation of the law changed is to establish the fact that the work itself is professional rather than subprofessional or of the technician type. I don't think I have any other comments.

PROF. IRISH: Sumner Irish, from Princeton University.

I would like to comment on something that Prof. Moffitt said regarding the training of the surveyor in college. I would like to compare the sort of work that the surveyor has to do, if I may, with cooking. It seems perhaps a little far fetched but I think it has its analogy.

In cooking, there are many, many husbands who fancy themselves amateur cooks and like to go out and barbecue, showing their skill and ability. Then, there is the woman of the house who has the job of preparing the meals from day to day, planning the meals, buying the food, cooking and serving it, and then cleaning up after

the job, doing the whole thing from start to finish. Then there is finally the man who is connected with cooking on a large scale—from the bakery on the corner, that has only a few men, all the way up to the national baking companies, with their tremendous operations.

In the first case, the husband who is out there playing away at cooking is comparable to the man Prof. Moffitt referred to as calling him up and wanting to know what books he could read to train himself to be a surveyor. He is playing around at it, just the way the husband does.

Then, there is the wife of the house who does the whole operation and has the whole responsibility. I would compare her to the surveyor who operates on a local basis and who, by and large, is represented by the property surveyor. He has to get in there, get his hands dirty, do the job, and know what is going on.

Then in the last operation, I would compare the firm that sets itself up to do surveying over an area of a State, or something like that, to the national baking company. Such organizations are the U. S. Geological Survey, as represented by Mr. Whitmore, or Aero Service Corporation, as represented by Mr. Quinn.

These are entirely different operations and they need, I think different training. The man who is doing the local surveying work is comparable to the housewife and is not trained the same way as the person working in the production process. Admittedly, some husbands who play at cooking, do get bitten by the bug and do carry through and develop large operations, the same as with wives. Some of them develop rather sizable cooking operations. But, those are few and far between.

Now, talking as one in the educational field, I think we have to face up to what type of people we are trying to train. Are we trying to train the person who will do the complete job from A to Z or are we trying to train the person who will be able to step into a surveying and mapping operation and be a supervisor to see that the job is done well. In that light, I look at the six divisions of the American Congress on Surveying and Mapping: Cartography, Control Surveys, Education, Instruments, Property Surveys, and Topography. I think we can eliminate the Education Division, as a type of operation.

Another division involves property surveys which includes going out and getting the job first, then doing the field work, working up the data, and putting it in a package that the client can use. In other words, the entire operation is generally one man's responsibility. It also includes a phase of the work that the other divisions do not. That is the legal end. At Princeton University, with which I am connected, I find this legal end of surveying something that is exceedingly technical and completely foreign to anything else to which our students are exposed. I make it a policy not to teach our men about property survey work. I think oftentimes, that if the student is exposed to property survey work, he will become an amateur, like the husband who is the cook. Property surveying isn't that easy and it needs an entirely different approach from that which we can give in the college.

But, I do think, in our college work, that we can train men in cartography, control surveys, instruments and topography. That, I feel, is our role, to train engineers who can be the supervisory type of personnel. Thank you.

MR. SMILEY: Francis Smiley, from the Colorado School of Mines.

I would like to ask Prof. Moffitt if he would elaborate on his statement of the professional courses given to these men who come in from wide distances and the level at which those courses take off, as compared to what they would get in a normal surveying course. I think this is very interesting and I am particularly interested in it. I agree with you on your definition between training and education.

PROF. MOFFITT: I can only give you the experience that I have gone through as long as I have been at California. The University of California Extension is quite extensive. In the last four and one-half years we have covered in our extension courses three separate courses on boundary

surveys and the legal aspects of boundary surveys. The latest one is being given at the present time by William Wattles. These courses are always well attended, 50 or more. This one happens to have 152, because the man is considered to be the best in the State. We have had three courses on the theory, operation, and use of the California Plane Coordinate System, because engineers out in California, if they can't use the coordinate system, are going to go out of business. This is hitting at the professional level, the engineers and the mappers.

We have had extension courses in least-squares, adjustments in which, unfortunately, none of our students in the first four years of college are interested. We have also had professional courses in photogrammetry, not getting into the technical aspect of plotting instruments and the geometry of photographs, but a discussion of the economics of the job, the planning, where the thing pegs off, where it is not economical to use photogrammetry. I considered that to be an extremely successful course. That was given a year ago last fall.

As I mentioned, three separate courses have been given so far in the use of the California Coordinate System. These include newer methods in mapping and direct at men who are practicing in the profession things they are not taught, as a rule, in college.

Boundary surveys, land surveying, and such, as Professor Smiley mentioned and as Professor Irish also touched on, are not taught in very many colleges. If they are, the material is taught in maybe two, three, or four lectures, and three of the four lectures are discussions of how you'd break down the section and how the public land survey operates. The other one perhaps deals with legal puzzlers in boundary surveys.

There is one course given at the City College of San Francisco by a "Mike" Aggeler, which, as far as I can see in nationwide curricula, is as exhaustive a treatment of the problems of land surveying and boundary surveying as I have ever seen. He takes up, among other things, the searching of the records, and he has his students down there in county and city offices delving through the records getting information. He takes them up to Sacramento and has them sit down at a little table and make tracings of a plat; sit down and transcribe notes in field books, and so on and so forth, and has them going out and searching for section corners. He does quite a lot of the things Mr. Wattles discusses in his course, but this is a two-year program and it is called the "Terminal Program," after which the man goes into the business of land surveying. This isn't taught as a part of a four-year program.

I was going to ask Prof. Irish just exactly where land surveying was going to be taught, if not in colleges. If it is not going to be taught in colleges, then there must be an apprentice deal where a young man goes into a land surveyor's office to learn the ins and outs. If there aren't enough men interested in this, I do not know where the land surveyors are going to come from 25 to 50 years from now.

Do you have any ideas on that, Prof. Irish?

PROF. IRISH: I will admit that does pose quite a problem and one for which I have no ready solution. As I say, I think of land surveying as a very technical matter, full of tremendous legalisms that are loaded with many traps for people who are not trained along that line. There are a great many mistakes which can be made. At the present time, I think that the best training for land surveying is a period of apprenticeship. I do not see anything wrong with an apprenticeship type of training in an office of a good land surveyor, getting into the many facets of this work.

I hesitate to consider a course adequate where a man has to go and search for one or two records in a courthouse. There is always something new that presents a challenge, as far as property surveying work is concerned. Now, where these men are going to come from in the future, I do not know, but at the present time, I think that we could do lots worse than having apprentice training.

Being attached to a college and having that background with a civil engineering degree, I took the examination for land sur-

veyor in the State of New Jersey, passed it, and got my license. I know very little about land surveying. I tried it and found out how little I knew. Now I am completely out of the business and glad to turn it over to somebody else who knows what is going on. I do not.

CHAIRMAN WEEDEN: I might comment that this can be put into the form of a "cliff hanger"—"Come tomorrow and find out." This subject is going to be touched on by our panel tomorrow, and the question will be raised again.

MR. KENNEDY: Daniel Kennedy, Rolla, Missouri, Regional Engineer, Geological Survey. At one time or another, I did teach a little surveying and mapping. It wasn't my idea to get up here and discuss anything this morning. I'm not like my friend out in Missouri who says he doesn't need one of these things. I am certain that in this meeting of mappers and surveyors, we could change our names to highway engineers, structural engineers, or any type of professional activity, and have the same problems that we are discussing this morning.

I think it comes down to a question of semantics, in a way, for I am sure that among us here this morning there are 25 definitions of a professional man. I have read quite a few definitions in the past year and I think the one I like best is the keystone of our professional thinking. Do you believe in what you are doing? Do you believe in all of it?

I would like to digress just a minute and start where I should have. I think this attempt by the "Task Force" is an excellent thing for us in the field of surveying and mapping. It is stimulating to me this morning and heartening to see young Prof. Moffitt get up here and tell us, as a teacher of surveying, what he thinks the professional teacher of engineering should do to develop this profession of ours. I am old fashioned, in a way, in that I think of surveying and mapping as a specialty of engineering. Now, I'm quite sure that there are other fields of education where mappers and surveyors, particularly since the war, have done as good a job as the civil engineers, but I keep thinking that there is an aspect that has not been dwelt on so far this morning. It is not just the operation of surveying and mapping but how it fits into the other fields of engineering that is really important.

Sometimes, in talking to these other specialists in the fields of engineering in the 16 states that comprise my region, highway engineers, State geologists, and those in teaching, I am appalled to find professional men and licensed engineers whose knowledge of surveying and mapping is wholly inadequate.

I think that it goes back a little, but not too much, to their undergraduate training, because we cannot blame everything on the teacher, although there is quite an attempt being made to do that today. We are trying to put the teacher in the category of the parent today. We do not like what the individual does and we say that his family did not give him the proper training or that he went to the wrong school. While that is true in some cases, it is not true in general. But, there is one point which I hope will come out of this meeting and that is, that we do not try to slice these working specialties too thin and make our categories too restrictive.

I do not think that we should dwell on the technician level too much, and by that I mean, let's not build a fence around him. If he has not had the advantage of a four-year course in school, that does not necessarily mean that he could never become an engineer. Learning is something that should be going on all the time and is certainly not restricted to the people with degrees. I also looked at the duties of the various sub-professional and technician grades. Knowing my own past, I have performed any and all of them. I do not think my belief in my own profession, and it has been a profession, has changed from the time I was a junior engineer many years ago.

I did not intend to make a big speech but I do hope that the objectives of this "Task Force" will be continued and I am

sure that, with a subject as dynamic as this is, we will continue to have these problems. Thank you.

CHAIRMAN WEEDEN: I would like to thank you, Mr. Kennedy, for your remarks as they pertain to attitude. I think this is a very significant element in professionalism and I think you did us a great service in bringing it out.

BROTHER AUSTIN BARRY: If I may, I would like to admit, with Mr. Kennedy and others, that there are going to be additional problems. We recognize, for example, that there is the problem of bidding for the use of surveying parties. I speak now specifically of other than land surveying. Because of instances of what has gone on in the Government, particularly the Corps of Engineers, the bidding of surveying parties for local mapping is very possibly something that can be clarified and used as a test against our further definition.

We admit too, that there is very likely an impossible situation, as we see it right now, of determining where the talents shall come from that will continue land surveying. That, incidentally, will come up for a little discussion tomorrow.

I would like to interject a personal opinion: admitting that no college today teaches land surveying, there is the possibility of having land surveyors trained through a triple scheme. Perhaps you will object to this, it is a personal opinion, but we could train them or educate them, as the case may be, in technical institutes. There I would use the word train. Then they would go through an apprenticeship and further enhance their professional stature through courses such as have been described as being given at the University of California.

We have additional problems too, that pertain to the mapping done on a competitive bid basis, very largely the production of maps by photogrammetric means. Possibly we will have to differentiate in that type of work between the engineering that goes into it and the actual work or product that is produced.

When you buy a toaster from G.E. or Westinghouse, you buy not only a product but also you buy some engineering. They have solved that problem and it does not seem to be particularly worrisome. Perhaps that analogy would help us in the solution of this particular problem regarding the production of photogrammetric maps.

I would like to encourage all of you to obtain copies of the Task Committee Report and perhaps engage in the discussion. None of us on the Committee feels that he is bound or capable of legislating in this regard. About the best we can do is reflect the best opinion and try to encourage consolidation of all of those best opinions. Certainly direction from you interested people is going to be very helpful.

MR. WHITMORE: I would like to add a few comments about the work of the Committee and some of the results of it so far, that I think are interesting. In the first place, I would like to tell you how the Committee operated. The three men live in three different cities: New York, Philadelphia, and Washington, and we met at different times during the year before the final report was produced. Each time we had a day-long meeting in one of these three cities, with all expenses paid, of course, by the Society. That was the way we did our work. Most of the summing up was done by the Chairman, Brother Austin.

Secondly, I think we ought to consider just a moment what we are talking and thinking about when we use the word "technician." If you will envision the whole team as having first, a professional man; next, the technicians; at the next level, skilled craftsmen; and at the next level, the laborers or the artisans; you can then sort of get your own idea of where the technician fits in. The technician is not an untrained man. He must have some training and he must be educated, to some extent. Most of us think of the technician as being the two-year man, having the equivalent of a junior college degree of some sort.

I would like to have you note also that this report has already created quite a stir and a lot of people have been talking about it on a national scale. Some of the State license boards have already said that they

would adopt it as their "bible" for allowing professional versus nonprofessional experience. But, the *Engineering News Record,* in particular, carried a rather lengthy editorial about it, called it a trail-blazing thing in engineering and said that for the first time, a group of specialists in engineering had been able to define pretty clearly what ought to be professional and what ought to be technician's work, and thus change the ratio of professional men to technicians. This editorial then went on to say that what the Surveying and Mapping Division had done, the other technical divisions of ASCE must do if they are going to keep up with things and keep out of trouble. Now, of course, there are 14 or 15 other technical divisions in the ASCE, so it looks as though they have their jobs to do, just as we had our job to do.

I would like to call your attention to the fact that other professions have had similar problems and probably still have them. I am reminded mainly of the medical profession. For years, pathologists in the medical profession were not regarded by the rest of the "medics" as fully professional people. I think that, in the old days, the pathologists, who were mainly laboratory men and made laboratory diagnoses, probably did not have the full medical degree. They possibly had what we think of now as a technician's training. But ultimately, eventually, and gradually, more and more of those pathologists came to have the full M.D. degree. Yet, they did not have the recognition of their associates in the medical field. They had to put on a fight, which they did successfully. They contended, over a period of several years, that they were just as much entitled to professional recognition as the other members of the medical profession and finally got the M.D.'s, as a group, to agree, so that today they are fully professional people.

I think possibly, surveying and mapping people might be in a similar category. Now, looking ahead just a little bit, as to whether this work or any part of it is engineering or not, I would like to call your attention to the fact that in 1952, the Board of Direction of the American Society of Civil Engineers adopted a resolution saying in very plain words that the kind of work that is involved in making geodetic and topographic surveys and maps and other types of similar surveying and mapping is engineering in their view. Thus, as of now, the Society is on record as saying that certain parts of this field will be considered by that Society to be engineering.

Where we are having our main trouble, I think, is with the State license boards and with the public. The fact that we have these complications of administration, codes of ethics, and administering State laws, is what is bringing on some of the trouble.

Another recent development that is interesting, but not directly in connection with this report, is a trend of the times perhaps. As you know, Ohio State University has offered graduate training for geodetic, photogrammetric, and mapping personnel, but these courses are not in the engineering school or administered by the engineers. It is an interdepartmental setup.

Recently, George Washington University proposed to set up within the Department of Geography, a four-year program leading to a degree in cartography. It would be actually a B.S. degree in geography with the option of cartography. The University called several of us in to a meeting to ask what we thought about their proposed program, and, incidentally, it is quite an ambitious program. They offer to teach almost everything that all of the civil engineering courses combined would teach regarding surveying and mapping, except they did not go quite high enough in mathematics or have enough required courses, such as geodesy and astronomy. Nevertheless, they get more actual surveying and mapping in that program than you could anywhere in a single civil engineering course. Most of the people who attended the meeting expressed the opinion, "This is fine. Let's get to doing it. We can use those people just as soon as you start turning them out."

I took a slightly different view and cautioned them to consider it further because of the possibility that it might be deemed to be engineering and fall legally and morally un-

der the jurisdiction of engineering. If so, the people that graduated from that school with a degree of geographer, cartography option, would be out of face with things. They wouldn't be able to command the positions that the engineers would be able to command. They would be misfits. However, it is an interesting thing to consider that Ohio State, first, and now George Washington University are proposing this particular kind of an educational program that is not in the engineering school.

Another interesting and recent development bears on the subject somewhat. The National Science Foundation, as you know, is a new Government agency that assists in coordinating all scientific research in the country and which has Government funds for carrying out its mission. By law it is charged with maintaining an up-to-date roster of scientific personnel of the country. One of the purposes of such a roster would be in time of an emergency to quickly call on any number of specialists in each field after finding out who those specialists were. I think that the roster has been published twice, and they are about ready to publish it again. Somebody discovered that surveying and mapping people weren't very well represented in that roster. Under the general title of "Earth Sciences," Geodesy was mentioned. Under the heading of "Geography," which was also under "Earth Sciences," Cartography was mentioned once. Under the heading of "Civil Engineering," there were two mentions of surveying. One was called "Surveying, Surface," meaning ground surveying, and the other was called "Surveying, Aerial." So, there were four places where surveying and mapping people were mentioned, but they were in three different places on the list, once under Geophysics, once under Geography and twice under Civil Engineering.

Everybody who studied the matter thought that was a pretty poor representation for surveying and mapping people, who are very important people in time of emergency, and that there ought to be some way to collect all those into one list. So, we organized a small informal committee. I represented the American Society of Engineers, because of my association on this Committee; Admiral Karo and Walter Dix represented the Congress on Surveying and Mapping; and William Cude and Earl Palmer represented the American Society of Photogrammetry. We met with the people of the National Science Foundation and we submitted a recommendation, which I think is going to be acted on, that there be a subheading under Engineering. It would not be under Civil Engineering, but rather under Engineering with a subheading called "Surveying, Mapping, and Photogrammetry." Under the subheading, there will be six, seven, or eight, I forget how many, categories corresponding to the professional titles that we have in this report. The next one of those rosters that comes out will have surveying and mapping people treated in a very different way.

Those are things that I thought would interest all of you in connection with this whole problem. Thank you.

CHAIRMAN WEEDEN: Thank you. George is suggesting that perhaps we should indulge in calling on you, Ford Bartlett, for a few remarks before we close this meeting.

MR. BARTLETT: The only thing that I would like to do would be to commend the Committee on its work, for which I am very grateful. As a professional engineer, as a land surveyor, and as a photogrammetrist, I feel that the work of the Committee has been most illuminating. I didn't realize that the ASCE had gone so far as to declare that it was professional sometime ago and my only concern was that the Committee's report hadn't gone far enough to say that it was an engineering service and had sort of avoided that question.

But, it certainly has been most helpful, and I wanted to tell Professor Moffitt, that, in talking with some of these highway engineers, three of them chief engineers of State highway departments, one of them was Mr. Reynolds from California, they have expressed the opinion that this bidding on mapping work is a complete negation of all professional standards. They do not get the type of work they would like. As a result, they would very much like to see a standard form of fees and code of ethics established.

As you know, checking maps sometimes is a lot more expensive than making them.

That is all I would like to add. Thank you.

CHAIRMAN WEEDEN: Thank you, Mr. Bartlett.

I am sure that there might be others who would like to make comments, but I am afraid we will have to close, in that the noon hour has already passed.

I would like to thank you all for your attendance here this morning, your patient interest, and with that, I will declare this morning session adjourned.

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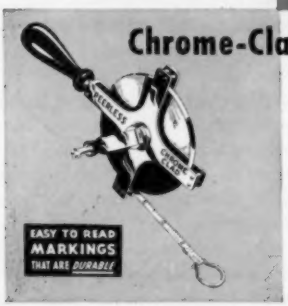

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CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

General Interest

GEOMAGNETISM IN THE INTERNATIONAL GEOPHYSICAL YEAR. Captain Elliott B. Roberts and David G. Knapp. *The Journal, Coast and Geodetic Survey,* No. 6, August 1955. (Explains the very difficult problems involved in determining magnetic forces which affect control surveys.)

ON DUTY WITH THE INTER-AMERICAN GEODETIC SURVEY. Commander Edward B. Brown. *The Journal, Coast and Geodetic Survey,* No. 6, August 1955. (Describes arduous task of surveying through jungle lands.)

MAPPING THE EARTH. Rear Admiral Robert W. Knox. *The Journal, Coast and Geodetic Survey,* No. 6, August 1955. (A valuable historical discussion of world mapping.)

REPORT OF COMMITTEE ON A LOOSE-LEAF NATIONAL ATLAS. *The Journal, Coast and Geodetic Survey,* No. 6, August 1955. (Reports recommended specifications.)

SOME LEGAL ASPECTS OF THE WORK OF THE COAST AND GEODETIC SURVEY. A. L. Shalowitz. *The Journal, Coast and Geodetic Survey,* No. 6, August 1955. (This article deals with the multiple questions arising from the so-called tideland oil problems.)

EXTRACTS FROM FIELD REPORTS. A section in *The Journal, Coast and Geodetic Survey,* No. 6, August 1955, which will be of interest to engineers and surveyors.

ARMY MAP SERVICE. Colonel J. D. Abell. *The Journal, Coast and Geodetic Survey,* No. 6, August 1955. (One of a series on the history, organization, and present activities of the major surveying and mapping agencies of the Federal Government.)

MEANING OR INTERPRETATION OF ENGINEERING ETHICS. R. W. Cloues. *Journal, Florida Engineering Society,* Vol. 9, No. 4, December 1955. (Paper presented at the Panel Discussion on Ethics, Florida Engineering Society Convention, Daytona Beach, Florida, April 21, 1955.)

ENGINEERS AND PROFESSIONAL RECOGNITION. C. W. Griffin, Jr. *Journal, Florida Engineering Society,* Vol. 9, No. 4, December 1955. (General discussion and comparison of the status of the engineering with the medical and legal professions.)

ETHICAL ASPECTS OF BIDDING FOR ENGINEERING SERVICES. Stanley W. Hole. *Journal, Florida Engineering Society,* Vol. 9, No. 4, December 1955. (Discussion of various aspects of the subject.)

THE INTERNATIONAL BOUNDARY. A. F. Lambert. *The Canadian Surveyor,* Vol. 12, No. 10, December 1955. (A rather detailed history of the establishment of the various segments of the Alaska-Canada and U.S.-Canada International Boundaries.)

THE 1837 MAPS OF HENRY DRURY HARNESS. Arthur H. Robinson. *The Geographical Journal,* Vol. 71, Part 4, December 1955. (Essay in historical cartography concerning early transportation maps of Ireland.)

HYDROGRAPHIC SURVEYS BY OFFICERS OF THE NAVY UNDER THE LATER STUARTS. G. P. B. Naish. *The Journal of the Institute of Navigation,* Vol. 9, No. 1, January 1956. (Interesting historical discussion of early charting and mapping activity.)

Cartography

ACETATE DRAWINGS. Wallace A. Bruder. *The Journal, Coast and Geodetic Survey,* No. 6, August 1955. (Analysis of a new technique in chart preparation.)

RAPID PRODUCTION OF FIELD CHARTS IN FORWARD AREAS FOR USE OF THE FLEET. Commander Franklin R. Gossett. *The Journal, Coast and Geodetic Survey,* No. 6. Aug-

ust 1955. (Comment on a valuable service performed in the Pacific Islands during World War II.)

MYRIADS OF MAPS. Richard H. Dillon. *The Social Studies*, Vol. 46, No. 8, December 1955. (A history of map making.)

REPORT ON STATE-WIDE SURVEYING AND MAPPING. Jon S. Beazley, Chairman, Florida State Mapping Advisory Committee. *Journal, Florida Engineering Society*, Vol. 9, No. 4, December 1955. (Summarizes mapping activity in Florida by various agencies and gives an account of the semi-annual meeting of the SMA committee.)

HOW TO DO COLOR STRIPPING FOR SPECIALIZED LITHO FIELDS. Bernard L. Halpern. *Modern Lithography*, Vol. 24, No. 3, March 1956. (Includes comment on map and chart reproduction.)

THE WEB OFFSET PRESS. Walter A. Simpson. *The National Lithographer*, Vol. 63, No. 4, April 1956. (Part I of a discussion of a rather controversial subject concerned with reproduction methods which could apply to map and chart printing.)

Control Surveys

RESECTION BY INTERSECTION. Erwin Schmid. *The Journal, Coast and Geodetic Survey*, No. 6, August 1955. (Mathematical discussion of a well known problem.)

THE THREE POINT PROBLEM. Lansing G. Simmons. *The Journal, Coast and Geodetic Survey Journal*, No. 6, August 1955. (Companion piece to article by Mr. Schmid cited above.)

MOVEMENT OF TRIANGULATION MARKS SET IN PERMAFROST. Commander J. T. Jarman, *The Journal, Coast and Geodetic Survey*, No. 6, August 1955. (Describes problems in connection with arctic surveying.)

GEODETIC WORK OF THE COAST AND GEODETIC SURVEY. Captain Albert J. Hoskinson. *The Journal, Coast and Geodetic Survey*, No. 6, August 1955. (Describes current activity in precise surveying.)

CROSSING OF FJORDS WITH PRECISE LEVELING. G. Jelstrup. *Bulletin Géodésique*, No. 38, December 1955. (Discussion of methods and results of difficult leveling operations.)

GRAVIMETRIC TIES, EUROPE-AMERICA. Carlo Morelli and Donald A. Rice. *Bulletin Géodésique*, No. 38, December 1955. (Account of the Rome-New York connection recently established.)

THE HEIGHT OF LAKE TANA, ETHIOPIA. Colonel D. R. Crone. *Empire Survey Review*, Vol. 13, No. 99, January 1956. (Account of the redetermination of the elevation in connection with selection of a townsite.)

DETERMINATION OF AZIMUTH AND LATITUDE FROM OBSERVATIONS OF A SINGLE UNKNOWN STAR BY A NEW METHOD. Dr. A. Tarczy-Hornoch. *Empire Survey Review*, Vol. 13, No. 99, January 1956. (Mathematical discussion of the method employed.)

ÜBER DIE REDUKTION GROSSER ELEKTRONISH GEMESSENER ENTFERNUNGEN. K. Rinner. *Zeitschrift für Vermessungswessen*, Vol. 81, No. 2, February 1956. (Mathematical discussion of method of reduction of long distances measured by electronic methods.)

DAS INTERNATIONALE METER UND SEINE FESTLEGUNG. K. Ledersteger. *Zeitschrift für Vermessungswesen*, Vol. 81, No. 2, February 1956. (Discussion, in German, of the International Meter and the background of its determination.)

MEN WHO MEASURE THE EARTH. Robert Leslie Conly. Illustrated with color and black-and-white photographs by John E. Fletcher. *The National Geographic Magazine*, Vol. 59, No. 3, March 1956. (Describes the program and the work of the Inter-American Geodetic Survey.)

Education

STATE ROAD DEPARTMENT OF FLORIDA IN-SERVICE TRAINING PROGRAM. T. L. Bransford. *Journal, Florida Engineering Society*, Vol. 9, No. 4, December 1955. (Description of subjects covered and results obtained.)

ENGINEERING ETHICS AND THE TEACHING PROFESSION. John E. Kiker, Jr. *Journal, Florida Engineering Society*, Vol. 9, No. 4, December 1955. (Urges stricter adherence to the Canons of Ethics of the National Society of Professional Engineers with particular reference to registration.)

THE ENGINEER SURVEYOR. A. J. Rusk. *Empire Survey Review*, Vol. 13, No. 99, January 1956. (General discussion of the training required for surveyors cooperating with other specialties in the engineering profession.)

Instruments

THE "AUTOMATIC" LEVEL. Howard S. Rappleye. *The Journal, Coast and Geodetic Survey*, No. 6, August 1955. (Detailed description of the Zeiss-Opton Ni2.)

PHOTOGRAMMETRIC INSTRUMENTATION AND PROCEDURES AS AN AID TO THE GEOLOGIST. John I. Davidson. *The Canadian Surveyor,* Vol. 12, No. 10, December 1955. (Describes activity of a Geological Survey inter-division committee representing the Geologic and Topographic Divisions, for the purpose of studying and advising on new instruments and methods of especial value to field geologists.)

A PNEUMATIC APPARATUS FOR MEASURING THE FLATNESS OF PHOTOGRAPHIC PLATES. J. C. Evans and I. B. Morgan. *Empire Survey Review,* Vol. 13, No. 99, January 1956. (Illustrated description of the device which may be adapted to other tests.)

Property Surveys

SURVEYING AND MAPPING IN THE PULP AND PAPER INDUSTRY. John G. Barnard. *Journal, Florida Engineering Society,* Vol. 9, No. 3, October 1955. (Mechanics and methods employed by a leading pulp and paper concern in surveys to appraise its raw material and an account of steps taken to avoid depletion.)

THE ORGANIZATION OF THE ASSOCIATION OF NEW BRUNSWICK LAND SURVEYORS. W. F. Roberts. *The Canadian Surveyor,* Vol. 12, No. 10, December 1955. (Account of the culmination of many years of effort to form the association and the preparation of the enabling act.)

LEGAL ASPECTS OF LAND SURVEYING IN NOVA SCOTIA. Malachi Jones. *The Canadian Surveyor,* Vol. 12, No. 10, December 1955. (Discussion of laws affecting boundaries, descriptions, and monumentation by a member of the legal staff, Department of the Attorney-General of Nova Scotia.)

PROPER DEED DESCRIPTIONS. Bill L. Bryant. *Journal, Florida Engineering Society,* Vol. 9, No. 4, December 1955. (Cites some horrible examples of vague and incorrect land descriptions and sets forth guiding principles for proper descriptions.)

LAND REGISTRATION IN BUGANDA. T. N. N. Brushfield and A. J. Relton. *Empire Survey Review,* Vol. 13, No. 99, January 1956. (Part I of a critical discussion of the Uganda basic laws concerning land apportionment.)

USE OF THE U.S. PUBLIC LAND SURVEY PLATS AND NOTES AS DESCRIPTIONS. William D. Pattison. *The Professional Geographer,* Vol. 8, No. 1, January 1956. (Describes the records and their origins and surveys geographical literature in which they have been utilized.)

Topography

DANISH TOPOGRAPHICAL MAPS OF GREENLAND. Notes section. *The Polar Record,* Vol. 8, No. 2, January 1956. (Lists maps of Greenland at scales of 1:300,000, 1:125,000, 1:50,000 and maps of settlements at 1:2,000. Includes index showing the two main series.)

BOOKS AND PAMPHLETS

UNIVERSAL TRANSVERSE MERCATOR GRID. U. S. Army Map Service. Washington 1955, 66 pp., (AMS Technical Manual No. 19.)

MANUAL OF MAP READING, AIR PHOTO READING, AND FIELD SKETCHING. Part I: Map reading, 1955. Great Britain, War Office. London, HMSO, 1955. 132 pp.

LATITUDE TRANSFORMATION, HAYFORD SPHEROID. GEODETIC LATITUDE TO ISOMETRIC LATITUDE AND ISOMETRIC LATITUDE TO GEODETIC LATITUDE. U. S. Lake Survey. New York, 1955. 135 pp.

A DESCRIPTION OF ORDNANCE SURVEY MEDIUM SCALE MAPS. Great Britain, Ordnance Survey. Chessington, 1955. 20 pp.

INVESTIGATION OF THE ACCURACY OF PLOTTING AND SCALING-OFF. N. D. Haasbroek. Netherlands Geodetic Commission, Delft, 1955. 176 pp.

REPORT OF THE FOURTH ANNUAL TEXAS SURVEYORS ASSOCIATION SHORT COURSE, AUSTIN, TEXAS, OCTOBER 10, 11, AND 12, 1955. Austin, 1955. 93 pp. (Includes several papers presented during the course, and a roster and other general information pertaining to the Association.)

A GUIDE TO THE COMPILATION AND REVISION OF MAPS. U. S. Department of the Army. Washington, Government Printing Office, 1955. 167 pp.

GEODETIC BASE LINES. J. E. Lilly. Canada. Dept. of Mines and Technical Surveys. Geodetic Survey. Publication 73. Ottawa 1955. 74 pp., map.

THE ORDNANCE SURVEY ANNUAL REPORT 1954–55. London, Her Majesty's Stationery Office, 1955. 23 pp., 20 plates showing status and progress.

LUFTPHOTOGRAMMETRISCHE VERMESSUNG DER FLURBERININIGUNG "BERGEN." Oberregierungs- und Vermessungsrat Schirmer, Mainz and Dipl.-Ing. Brucklacher, Oberkochen. Kleins Druk-und Verlagsanstalt GMBH in Lengerich (Westf.) 1955. 118 pp., illus.

—LYMAN D. LYNN
Coast and Geodetic Survey

DISTINCTIVE RECENT MAPS

A map showing *Potash Occurrences in the United States* by Mary Frances Byrd was published in 1955 by the U. S. Geological Survey. The purpose of the map "is to summarize the potash occurrences in the United States that have been most commonly referred to in the literature, regardless of their economic importance." The map measures 24 by 39 inches and is at the scale of 1:5,000,000. Copies are for sale by the U. S. Geological Survey for fifty cents.

A new pictorial map of *Virginia 1602–1622* "Showing the most remarqueable parts thus named in the Ancient Records" has been prepared by Doris Van Dien Davis and Katherine Payne Adams. It was copyrighted in 1955 by the artists. The map is printed on brown antiqued paper and is decorated with ships, compass roses, fish, and native inhabitants after the style of seventeenth century maps. It measures 18 by 24 inches.

Round About the Nation's Capital is the title of the map supplement of the April 1956 number of the *National Geographic Magazine*. The map, printed in ten colors, includes descriptive historical notes spanning the period from 1607 to the present. The homes of nine presidents of the United States are located within the limits of this interesting map. It is designed to illustrate Howell Walker's article "History Keeps House in Virginia." The scale is 9.2 miles per inch.

A *Mineral Industry Map of Ohio* at the scale of 1:500,000, was published in 1955 by the Ohio Department of Natural Resources, Division of Geological Survey. It was prepared in cooperation with the Ohio Department of Industrial Relations, Division of Labor Statistics and Division of Mines. Deposits of coal, limestone, salt, gypsum, sandstone, sand and gravel, and clay are located. The map measures 34 by 30½ inches.

A map of *Oil and Gas Pipe Lines in Ohio* was compiled by Robert L. Alkire, and published in 1955 by the State of Ohio, Division of Geological Survey. The scale of the map is 1:500,000 and the dimensions are 42 by 30½ inches. In addition to pipe lines, refineries, terminals, and pumping stations are shown. The map borders include indexes of Gas Utilities, and Refinery and Pipe Line Companies.

Helen M. Martin is the compiler of a *Map of the Surface Formations of the Southern Peninsula of Michigan*. The map, at the scale of 1:500,000, published in 1955, is Publication 49 of the Geological Survey Division, Michigan Department of Conservation. Three small inset maps show sources of data, "approximate position of glacial fronts at times of building the moraines," and "areas of rock at or near surface, and geologic rock formations." The map measures 40 by 39 inches.

The Oil and Gas Journal *Guide to Gulf Coast Oil* shows oil fields, gas fields, salt domes, refineries, and the intercoastal canal system. Tables at the bottom of the map sheet list tanker terminals, refineries, natural-gasoline plants, cycling plants, and oil and gas fields, by states. The scale is 1:1,000,000 and the size 33½ by 45½ inches.

The Oklahoma Geological Survey published in 1955 a *Mineral Map of Oklahoma (Exclusive of Petroleum and Natural Gas Fields)*. It was prepared by John H. Warren and is at the scale of 1:720,000. The map sheet measures 25 by 43 inches. Colors and symbols locate and show distribution of the various minerals found within the state. Producers of specified minerals are indicated by numbered symbols on the map, which correspond with numbers in the descriptive legend.

The Census Bureau, U. S. Department of Commerce, published in 1955 a portfolio of *Census Atlas Maps of Latin America, Central America.* The nine maps include four regional maps of Central America all at the scale of 1:4,000,000 (1. Land Forms [by Raisz], 2. Climate Regions, 3. Natural Vegetation, 4. Roads and Railroads), and five Urban and Rural Population Maps of Countries (5. Guatemala-British Honduras, 6. Honduras and El Salvador, 7. Nicaragua, 8. Costa Rica, 9. Panama).

All the maps, except numbers 1 and 4, were planned and designed by F. Webster McBryde "as a long-range project of the graduate Seminar in the Geography of Latin America, Geography Department, University of Maryland for use in the Census Atlas Project."

The Census Atlas Project is part of the program of the Census Bureau, under an agreement with the International Cooperation Administration, U. S. Department of State.

Mapa del Norte de la Republica de Venezuela portrays northern Venezuela in hypsometric relief. It is at the scale of 1:1,500,000 and measures 21½ by 40 inches. The publisher is Compañia Shell de Venezuela. In addition to relief, the map shows air fields, railroads, two classes of roads, internal political boundaries, and towns and cities.

The Aero Relief Map of Europe is the most recent in the series of three-dimensional plastic relief maps produced by Aero Service Corporation, Philadelphia, Pennsylvania. The map is at the scale of 75 miles to the inch and is printed with gradient tints ranging from green to brown, which combine with the embossed plastic to portray relief.

International boundaries, railroads, canals, major drainage channels, and cities, classified by population, are also shown. The map, which measures 41 by 47 inches, retails for $45.00.

Monastic Britain, North Sheet maps the distribution and detailed character of the monastic houses from the eleventh to the sixteenth centuries. This sheet, now in its second edition, is one of a series of National Period maps published by the British Ordnance survey. The North Sheet includes the whole of the dioceses of Durham and Carlisle as well as Scotland. The scale of the map is 1:625,000 and the size 32 by 40 inches. An 18 page gazetteer accompanies the map.

Mineralquellen und Heilbäder maps the distribution of mineral springs, spas, and health resorts in Nordrhein-Westfalen and neighboring parts of Germany. The map, at the scale of 1:500,000, was compiled by K. Fricke, and published in 1955 by Amt für Bodenforschung, Landesstelle Nordrhein-Westfalen, Düsseldorf. The sheet measures 32 by 21 inches and is issued as part of the Nordrhein-Westfalen Atlas.

The [French] Institut Geographique National published in 1954 a two-sheet map of *Cameroun* at the scale of 1:1,000,000. Each sheet measures 24 by 32 inches. The map shows railroads, several classes of roads, internal administrative divisions, towns and cities, classified by size, major water bodies, and spot elevations.

Two maps of French West Africa were published in 1954 by Direction de la Documentation, [France] Secretariat General du Gouvernement. Both are at the scale of 1:5,000,000 and measure approximately 23 by 31 inches. *Carte Administrative* shows internal administrative boundaries of French West Africa, as well as international boundaries for adjacent territories and independent states. Small inset maps show (1) distribution of racial groups, and (2) educational centers.

The *Carte Economique* maps the location and distribution of economic resources and industrial centers, and traces the major land, water, and air transportation networks. It also gives the limits of irrigation zones, swamps, and sand deserts.

Incidence of endemic goiter in French West Africa is shown on a map entitled *Carte de Repartition du Goitre Endémique en Afrique Occidental Française*. It is based on statistics for the years 1948 to 1950 compiled by the Ministries of Medicine and Public Health of French West Africa. The scale is 1:2,000,000, and the map measures 36 by 26½ inches.

Cambodge-Laos-Viet Nam Croquis Physique et Routier, is a physical-transportation map of the new countries which formerly formed part of French Indo-China. This second edition of the map was publsihed in 1954 by Service Géographique de l'Indochine, Dalat. The map measures 36 by 24 inches and is at the scale of 1:2,000,000.

The complex of languages in Indo China are presented on *Carte Ethnolinquistique* published in 1949 (reprinted 1952) by L'Ecole Française d'Extrême-Orient and le Service Geographique de l'Indochine. The scale is 1:2,000,000 and the size 34 by 24 inches.

—WALTER W. RISTOW

Library of Congress

Embossed Maps for the Blind

During April 1956 the Perkins School for the Blind, Watertown, Mass., presented an exhibit, in the Blindiana Museum, entitled "A Century and a Quarter of Embossed Maps for the Blind." The exhibit included 37 items ranging in date from 1833 to 1956.

Because schools for the blind throughout the world have always considered the use of three-dimensional or relief maps essential to the teaching of geography, maps produced in many countries were displayed. The earliest map exhibited, an 1833 embossed map of New England, was prepared at Perkins by Samuel Gridley Howe. The Perkins School's Howe Press continues to be an active publisher of embossed maps for the blind.

—WALTER W. RISTOW

Library of Congress

Books in Review

REALMS OF WATER. P. H. Kuenen. *John Wiley & Sons,* New York, 1955. 327 pp. $6.50.

This book is a delightful description of many of the phenomena of the earth's water. Except for a large number of incorrect details, the book is scientifically sound—particularly in its geological aspects. The book is not a text, nor a comprehensive treatise. It is entertainingly written, and marked with skillful and occasionally colorful style. This reviewer found about one typographic error per chapter.

The brief first chapter introduces the book by indicating many of the cycles through which a particle of water might journey, and gives some of the physical properties of water in its three phases. Water is erroneously said to have greater surface tension than any other fluid—mercury being overlooked; and to have greater heat of fusion and specific heat than any substance other than ammonia—there being but few exceptions, however.

Oceanography is the subject of the second chapter, with emphasis on methods of sounding, tides and waves. Examples are taken from all over the world, in this and other chapters, and there are several photographs and many helpful diagrams. Considerable attention is given to ocean circulation and the work of the ocean on the earth's crust. Items of particular interest are design problems of the Zuider Zee, and the storage of carbon dioxide in the ocean —a topic of current interest with respect to speculation as to the influence of possible increase of carbon dioxide content of the atmosphere on climatic trends.

Water in the atmosphere is discussed in the third chapter, in which a discussion of the earth's radiation balance is poor in places. The solar constant is given as 2 calories per cm.^{2} per min., "subject to variations of 10% through sunspots." It is stated as axiomatic that the climate of the earth is not getting warmer. Clouds are discussed rather comprehensively. Hailstones of ten inches' diameter and eight pounds' weight are claimed to have been observed, but no source is given for this statement.

Chapter four discusses water in the solid state, being mostly a discussion of glaciers and their geologic processes, though snow is discussed to some extent—mostly in connection with avalanches. Regularly recurring avalanches are said to cover half the area of Switzerland. This reviewer is not qualified to state the correct percentage of Swiss area covered by avalanches, but feels obliged to question this statement. Various types of glaciers are described and their alimentation is touched upon briefly. There is brief qualitative reference to some of the theories of the ice ages.

Ground water is the subject of chapter five. The greatest emphasis is given to springs, geysers and caves. Nearly all the flow of rivers is said to come from ground water, whereas estimates of the water balance in the United States indicate that ground water comprises about 30% of the flow of streams. Capillary water is discussed in a general way. Phreatophytes are overlooked in a broad statement of the effect of ground water on plants. "Old Faithful," in Yellowstone, is said to have the "utmost regularity," yet its frequency of activity is known to vary from about a half hour to an hour and a half. The word *corrosion* is used in several places in the book, where erosion or corrasion is evidently meant.

Water on the surface is discussed in chapter six. Influent and effluent streams are described. Waterfalls are given much attention, also geomorphology including lakes and the work done by rivers. Lake ice is said to encroach on the shores with "irrestible" force when it expands. A table giving the height and power of waterfalls has several errors and inconsistencies, including citing Niagara with a height of 67 feet. The dynamics of streams is given an excellent qualitative treatment.

The final chapter is entitled "A Balance Sheet of Terrestrial Water," but there is no expected quantitative accounting of water in the various stages of the hydrologic cycle. The book has a helpful index and several general references, but no specific documentation.

—Walter Wilson

Hydrologic Services Division
Weather Bureau

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession.

—EDITOR

Topographic Maps

THE FOLLOWING quadrangle maps were published by the U. S. Geological Survey between December 1, 1955 and February 29, 1956. The list includes newly compiled maps; revised maps on which contours and drainage usually are unchanged but the works of man are brought up to date; and series-converted maps which are 15-minute maps produced from four 7½-minute maps of the same area. The maps are new unless otherwise designated by numerical superscript.

The quadrangle name (in capital letters) is followed by the name of the county (in upper- and lower-case letters) that contains the place or feature for which the quadrangle is named.

All maps are available with or without the green overprint that indicates woodland. These maps show the shape and elevation of the land surface (represented by contour lines, printed in brown—except those marked with the letter (P), which are planimetric); water features (in blue); works of man, including cities, towns, and scattered habitations, schools, churches, railroads, roads and boundaries, place and feature names (in black); and woodland areas (in green). Principal roads are shown by a red overprint. In areas that have been covered by Bureau of Land Management Surveys, township and section lines are shown. The State rectangular coordinate systems are indicated in the margins of the maps. An information folder further describing topographic maps is available on request.

Standard quadrangle maps may be obtained for 20 cents per copy. A discount of 20 percent is allowed on orders amounting to $10 or more at the retail price. Orders should be addressed to the U. S. Geological Survey, Washington 25, D. C., (or Denver 15, Colorado, for maps of areas west of the Mississippi River).

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* Indicates 15-minute quadrangle; all others are 7½-minute quadrangles.

[1] Indicates a revised map.

[2] Indicates a series-converted map.

† Indicates availability in either a contour or a shaded-relief edition.

‡ Indicates preliminary black and white edition.

Alaska

AFOGNAK (A-2)*—Third Judicial Division
AFOGNAK (A-3)*—Third Judicial Division
AFOGNAK (B-1)*—Third Judicial Division
AFOGNAK (B-2)*—Third Judicial Division
AFOGNAK (B-3)*—Third Judicial Division
AFOGNAK (C-1, C-2)*—Third Judicial Division
AFOGNAK (C-2, C-3)*—Third Judicial Division
BENDELEBEN (B-1)*—Second Judicial Division
BENDELEBEN (B-2)*—Second Judicial Division
BENDELEBEN (B-3)*—Second Judicial Division
BENDELEBEN (B-4)*—Second Judicial Division
BENDELEBEN (B-5)*—Second Judicial Division
BENDELEBEN (C-1)*—Second Judicial Division
BENDELEBEN (C-2)*—Second Judicial Division
BENDELEBEN (C-3)*—Second Judicial Division
BENDELEBEN (C-4)*—Second Judicial Division
BENDELEBEN (C-5)*—Second Judicial Division
BENDELEBEN (C-6)*—Second Judicial Division
BENDELEBEN (D-1)*—Second Judicial Division
BENDELEBEN (D-2)*—Second Judicial Division
BENDELEBEN (D-3)*—Second Judicial Division
BENDELEBEN (D-4)*—Second Judicial Division
BENDELEBEN (D-5)*—Second Judicial Division
BENDELEBEN (D-6)*—Second

Judicial Division
CANDLE (A-5)*—Second Judicial Division
CANDLE (A-6)*—Second Judicial Division
CANDLE (B-5)*—Second Judicial Division
CANDLE (B-6)*—Second Judicial Division
CANDLE (C-5)*—Second Judicial Division
CANDLE (C-6)*—Second Judicial Division
CIRCLE (C-5)*—Fourth Judicial Division
CIRCLE (C-6)*—Fourth Judicial Division
CIRCLE (D-5)*—Fourth Judicial Division
CIRCLE (D-6)*—Fourth Judicial Division
FAIRBANKS (D-5)*—Fourth Judicial Division
FAIRBANKS (D-6)*—Fourth Judicial Division
JUNEAU (A-1)*—First Judicial Division
KANTISHNA RIVER (C-3)*—Fourth Judicial Division
KANTISHNA RIVER (C-4)*—Fourth Judicial Division
KANTISHNA RIVER (D-1)*—Fourth Judicial Division
KANTISHNA RIVER (D-2)*—Fourth Judicial Division
KANTISHNA RIVER (D-3)*—Fourth Judicial Division
KANTISHNA RIVER (D-4)*—Fourth Judicial Division
KARLUK (C-1)*—Third Judicial Division
KODIAK (A-4)*—Third Judicial Division
KODIAK (D-5)*—Third Judicial Division
KODIAK (A-6)*—Third Judicial Division
KODIAK (B-4)*—Third Judicial Division
KODIAK (B-5)*—Third Judicial Division
KODIAK (B-6)*—Third Judicial Division
KODIAK (C-3)*—Third Judicial Division
KODIAK (C-6)*—Third Judicial Division
KODIAK (D-4)*—Third Judicial Division
KODIAK (D-5)*—Third Judicial Division
LIVENGOOD (A-1)*—Fourth Judicial Division
LIVENGOOD (A-5)*—Fourth Judicial Division
LIVENGOOD (D-1)*—Fourth Judicial Division
LIVENGOOD (D-3)*—Fourth Judicial Division
MT. FAIRWEATHER (A-1)*—First Judicial Division
MT. FAIRWEATHER (D-1)*—First Judicial Division
MT. McKINLEY (A-4)*—Fourth Judicial Division
MT. McKINLEY (B-5)*—Fourth Judicial Division
NOME (B-1)*—Second Judicial Division
NOME (C-2)*—Second Judicial Division
NOME (C-3)*—Second Judicial Division

Arizona

DINNE MESA SE—Apache
‡HOUSE ROCK SPRING NE—Coconino
‡HOUSE ROCK SPRING SE—Coconino
LECHE-E ROCK*—Coconino
‡SHINARUMP NW—Coconino

Arizona-California

PICACHO—Imperial

Arkansas

CHARLOTTE—Independence

Arkansas—Mississippi

LATOUR*[1]—Phillips

California

AMBOY CRATER—San Bernardino
AZUSA—Los Angeles
BAGDAD SW—San Bernardino
BURBANK—Los Angeles
CAPE SAN MARTIN*[2]—Monterey
CLEGHORN LAKES—San Bernardino
DEADMAN LAKE NE—San Bernardino
DEADMAN LAKE SW—San Bernardino
DOYLE*—Lassen
EL MONTE—Los Angeles
GLAMIS—Imperial
GOAT MOUNTAIN—San Bernardino
GOSFORD—Kern
JUNIPERO SERRO*[2]—Monterey
KING CITY*[2]—Monterey
LAVIC LAKE—Inyo
LEAD MOUNTAIN NE—San Bernardino
LITTLE LAKE*—Inyo
LOS VIEJOS[1]—Kings
MORGANS WELL—San Bernardino
NEBO—San Bernardino
OBSERVATION PEAK*—Lassen
OIL CENTER—Kern
OILDALE—Kern
PASO ROBLES*[2]—San Luis Obispo
RAVENDALE*—Lassen
RICE*—San Bernardino
SACRAMENTO EAST[1] — Sacramento
SAN DIMAS—Los Angeles
SAN MIGUEL*[2]—San Luis Obispo
SAN RAFAEL—Marin
SHINN MOUNTAIN*—Lassen
SILVER BELL MINE—San Bernardino
SUNSHINE PEAK—San Bernardino
SUTTER BUTTES—Sutter

California-Arizona

PICHACO NW—Yuma

Colorado

ALLISON—La Plata
CANYON OF LODORE NORTH—Moffat
CANYON OF LODORE SOUTH—Moffat
CARRACAS—Archuleta
DECKERS—Douglas
DEVILS HEAD—Douglas
GREEN MOUNTAIN—Jefferson
GUNNISON—Gunnison
HELLS CANYON—Moffat
IOLA—Gunnison
IRIS NW—Saguache
LITTLE SOAP PARK—Gunnison
LODORE SCHOOL—Moffat
McINTOSH MTN.—Gunnison
WEST ELK PEAK SW—Gunnison
WINDY PEAK—Park

Connecticut

ANSONIA—New Haven
SOUTHBURY—New Haven
SPRING HILL[1]—Tolland

Delaware-Pennsylvania

WILMINGTON NORTH — New Castle

Florida

BOYD—Taylor
BRONSON—Levy
BRONSON SW—Levy
CHIEFLAND—Levy
CHIEFLAND SW—Levy
CROOKED POINT—Taylor
CROSS CITY WEST—Dixie
EUGENE—Dixie
FENHOLLOWAY—Taylor
GREENVILLE NE—Madison
HAMPTON SPRINGS—Taylor
INVERNESS—Citrus
JOHNSON HAMMOCK—Taylor
LECANTO—Citrus
LLOYD—Jefferson
MANATEE SPRINGS—Levy
NOBLETON—Hernando
OKEFENOKEE SLOUGH—Taylor
OTTER CREEK—Levy
SPRING LAKE—Hernando
STEINHATCHEE SE—Dixie
WARRIOR SWAMP—Taylor
WOODVILLE—Leon

Florida-Georgia

SNEADS—Jackson

Georgia

CAMPBELLTON—Fulton
DESSER—Seminole
PALMETTO—Fulton
†WARM SPRINGS*—Meriwether

Georgia-Florida

STEAM MILL—Seminole

Hawaii

KAENA—Honolulu
SCHOFIELD BARRACKS—Honolulu

Idaho

EAGLE—Ada
MONTOUR*—Gem
SMITHS FERRY*—Valley

Illinois

MECHANICSBURG*—Sangamon
NIANTIC*—Macon
PARK RIDGE[1]—Cook

Illinois-Indiana

CALUMET CITY[1]—Cook
CALUMET LAKE[1]—Cook

Illinois-Kentucky

ROSICLARE—Hardin
SHETLERVILLE—Pope

Indiana

CRANDALL—Harrison
DUBOIS—Dubois
RICHLAND—Spencer

Kentucky

ALLEN SPRINGS—Allen
ANCHORAGE[1]—Jefferson
BALKAN—Bell
BALLARDSVILLE—Oldham
BARCREEK—Clay
BARTHELL—McCreary
BEVERLY—Bell
BLACKEY—Letcher
BLACKFORD—Webster
BLEDSOE—Harlan
BOWLING GREEN NORTH—Warren
BOWLING GREEN SOUTH—Warren
BRIENSBURG[1]—Marshall
BRISTOW—Warren
BURNSIDE—Pulaski
CALVERT CITY—Marshall
CANOE—Breathitt
COILTOWN—Hopkins
CREEKVILLE—Clay
CUTSHIN—Leslie

DALTON—Hopkins
DAVID—Floyd
DAWSON SPRINGS—Hopkins
DORTON—Pike
EDDYVILLE—Lyon
ELI—Russell
ELVA—Marshall
FARMINGTON—Graves
FAUBUSH—Pulaski
FREDONIA—Caldwell
GLASGOW NORTH—Barren
GREENSBURG—Green
HADDIX—Breathitt
HADLEY—Warren
HANDSHOE—Knott
HAROLD—Floyd
HARTFORD—Ohio
HAZARD NORTH—Perry
HAZARD SOUTH—Perry
HELTON—Leslie
HICKORY—Graves
HICO[1]—Fayette
HINDMAN—Knott
HISEVILLE—Barren
HORSE CAVE—Hart
HOSKINSTON—Leslie
KITE—Knott
KRYPTON—Perry
LEATHERWOOD—Perry
LEITCHFIELD—Grayson
LEXINGTON EAST[1]—Fayette
LEXINGTON WEST[1]—Fayette
LICK CREEK—Pike
LOUELLEN—Hardin
LUCAS—Barren
MADISONVILLE WEST — Hopkins
†MAMMOTH CAVE*—Edmonson
McDOWELL—Floyd
MEADOR—Allen
MELBER—McCracken
MIDDLESBORO NORTH—Bell
MILLARD—Pike
MILLERSTOWN—Grayson
MORGANTOWN—Butler
NEBO—Hopkins
NOBLE—Breathitt
NOLANSBURG—Harlan
NORTH PLEASUREVILLE — Henry
OGLE—Clay
PARK—Barren
PARK CITY—Barren
PIKEVILLE—Pike
PINEVILLE—Bell
POLKVILLE—Warren
PRESTONSBURG—Floyd
PRINCETON WEST—Caldwell
PROVIDENCE—Webster
RIVERSIDE—Warren
ROSINE—Ohio
ROXANA—Letcher
SAINT CHARLES—Hopkins
SCALF—Knox
SCIENCE HILL—Pulaski
SHELBYVILLE—Shelby
SIMPSONVILLE—Shelby
SLAUGHTERS—Webster
SMITHFIELD—Henry
SMITHS GROVE—Warren
SYMSONIA—Graves
SUGAR GROVE—Butler
TILFORD—Perry
UPTON—Hardin
VERNON—Monroe
VEST—Knott
VICCO—Perry
WALLINS CREEK—Harlan
WAYLAND—Floyd
WELCHS CREEK—Butler
WESTPLAINS—Graves
WHEELWRIGHT—Floyd
ZACHARIAH—Lee

Kentucky-Illinois

PADUCAH EAST—McCracken

Kentucky-Indiana

LA GRANGE[1]—Oldham

Kentucky-Tennessee

ADOLPHUS—Allen
FOUNTAIN RUN—Barren
HICKORY FLAT—Simpson
HOLLAND—Allen

Kentucky-Virginia

BENHAM—Harlan
ELKHORN CITY—Pike
EVARTS—Harlan
JAMBOREE—Pike
WHITESBURG—Letcher

Louisiana

BOYCE*[1]—Rapides
BUNKIE*[1]—Avoyelles
FORT LIVINGSTON*[1]—Jefferson
HAHNVILLE*[1]—St. Charles
MANIFEST*[1]—Catahoula

Maine

CARIBOU*[1]—Aroostook
SHIN POND*—Penobscot
STACYVILLE*—Penobscot

Maryland

BENEDICT—Charles
NORTH POINT*—Baltimore

Maryland-Virginia

MATHIAS POINT — Prince Georges

Massachusetts

ATHOL*[1]—Worcester

Michigan

BEACON HILL—Houghton
CENTRAL LAKE*—Antrim
CHARLEVOIX—Charlevoix
GAY—Keweenaw
GAYLORD*—Otsego
GRAVERAET RIVER—Houghton
KENTON*—Houghton
KEWEENAW BAY*—Baraga
MARQUETTE—Marquette
MARQUETTE NW—Marquette
NEGAUNEE—Marquette
NEGAUNEE SW—Marquette
OSKAR—Houghton
PELKIE*—Baraga
POINT MILLS—Houghton
RICE LAKE—Houghton
ROCKHOUSE POINT—Houghton
ROUSSEAU*—Ontonagon
TRAVERSE ISLAND—Houghton

Minnesota

ALBERT LEA*—Freeborn
BLOOMINGTON—Hennepin
EDEN PRAIRIE—Hennepin
HUGO—Washington
MARTIN LAKE—St. Louis
SAWYER—Carlton
STEPHEN*—Marshall

Mississippi

McHENRY*—Stone
VESTRY*—Jackson

Missouri

CENTERVIEW—Johnson
PASCOLA*—Pemiscot

Missouri-Arkansas

HAYTI*—Pemiscot

Montana

BAKER MONUMENT—Fergus
BASIN*—Jefferson
BELL RIDGE EAST—Phillips
BELL RIDGE WEST—Phillips
BIRD RAPIDS—Blaine
BOULDER*—Jefferson
COW ISLAND—Blaine
DARK BUTTE—Chouteau
ELK PARK*—Jefferson
FORT BENSON—Chouteau
GALLATIN RAPIDS—Fergus
GRAND ISLAND—Phillips
HESSLER RIDGE—Fergus
ILIAD—Chouteau
RICE RESERVOIR—Chouteau
ROSS CANYON—Sweet Grass
STURGEON ISLAND—Blaine
WALTHAM—Chouteau

Nebraska

AINSWORTH—Brown
AINSWORTH NW—Brown
AINSWORTH SW—Brown
ATKINSON—Holt
ATKINSON SE—Holt
BASSETT—Rock
CEDAR RAPIDS SE—Boone
GABLES—Garfield
GABLES NW—Garfield
GABLES SE —Garfield
GABLES SW—Garfield
GREELEY—Greeley
GREELEY NE—Greeley
GREELEY NW—Greeley
LONG PINE—Brown
MEEK SW—Holt
OPPORTUNITY—Holt
ORD—Valley
ORD NE—Valley
ORD NW—Valley
STUART—Holt

Nevada

BUFFALO MTN.*—Pershing

New Jersey

BOONTON[1]—Morris
MORRISTOWN[1]—Morris
PLEASANTVILLE—Atlantic
WASHINGTON[1]—Warren

New Jersey-New York

WAWAYANDA[1]—Sussex

New Jersey-Pennsylvania

BRIDGEPORT[1]—Gloucester
FLATBROOKVILLE[1]—Sussex

New Mexico

ARTESIA NE—Eddy
BURNT MESA—San Juan
HOLLOMAN*—Otero
HOPE NE—Eddy
LUMLEY LAKE*—Socorro
ROSA—Rio Arriba
TULAROSA*—Otero

New York

ALBANY—Albany
AUBURN—Cayuga
CAYUGA—Cayuga
DUANESBURG—Schenectady
EAST GREENBUSH—Rensselaer
FAIR HAVEN—Cayuga
NASSAU—Rensselaer
NISKAYUNA—Schenectady
OSWEGO EAST—Oswego
PATTERSONVILLE — Schenectady
SENECA FALLS—Seneca
TROY SOUTH—Rensselaer

North Carolina

WHITE LAKE*—Bladen

North Dakota

LANDA SE—Bottineau
SOURIS—Bottineau
SOURIS SE—Bottineau
SOURIS SW—Bottineau

Ohio

NEW CARLISLE—Clark

Oklahoma

TULSA—Tulsa

Oregon

ANLAUF*—Douglas
BONE MOUNTAIN*—Coos
CAPE BLANCO*—Curry
LANGLOIS*—Curry
MARIAL*—Curry
RICHMOND*—Wheeler
SCOTTS MILLS—Marion

Pennsylvania

AMITY—Washington
BENTON[1]—Columbia
BLOOMSBURG[1]—Columbia
COATESVILLE—Chester

EAGLES MERE*[1]—Sullivan
LAPORTE*[1]—Sullivan
LEECHBURG—Armstrong
MIDLAND—Beaver
NANTICOKE[1]—Luzerne
STILLWATER[1]—Columbia
SUNBURY*[1]—Northumberland
WARRENSVILLE*[1]—Lycoming

Pennsylvania-New Jersey

LAKE MASKENOZHA[1]—Pike

South Dakota

BATH—Brown
BELVIDERE NW—Jackson
DALY CORNERS—Brown
GROTON—Brown
JAMES—Brown
KADOKA NE—Jackson
KIDDER SE—Marshall
SAINT ONGE—Lawrence
SAINT ONGE SE—Meade
WENDTE NE—Stanley

Tennessee

BETHPAGE—Sumner
CRAWFORD—Overton
DE ROSSETT—White
LIVINGSTON—Overton
RUTHERFORD—Gibson

Texas

CORLEY—Bowie
LA PARRA RANCH*[2]—Kenedy
LA PARRA RANCH SW—Kenedy
LLOYD MOUNTAIN—Scurry
MAUD—Bowie
POTRERO CORTADO*[2]—Kenedy
NEW BOSTON—Bowie

Utah

ANTELOPE ISLAND—Davis
DUGWAY PROVING GROUND SE—Tooele
DUGWAY RANGE*—Tooele
‡JOHNSON NE Kane
McINTYRE—Juab
‡MT. ELLEN 1 NW—Wayne
‡MT. ELLEN 1 SW—Wayne
‡MT. ELLEN 2 NE—Wayne
‡MT. ELLEN 2 NW—Wayne
‡MT. ELLEN 2 SE—Wayne
‡MT. ELLEN 2 SW—Wayne
‡MT. PEALE 1 NW—San Juan
‡MT. PEALE 1 SW—San Juan
‡MT. WAAS 1 NW—Grand
‡MT. WAAS 3 NE—Grand
‡MT. WAAS 3 NW—Grand
‡MT. WAAS 3 SE—Grand
PUBLIC SHOOTING GROUNDS—Box Elder
TICKVILLE SPRING—Utah

Utah-Arizona

CUMMINGS MESA*—San Juan
‡JOHNSON SE—Kane
‡JOHNSON SW—Kane
NAVAJO MOUNTAIN*—San Juan

Utah-Colorado

‡MT. PEALE 1 NE—San Juan
‡MT. PEALE 1 SE—San Juan
‡MT. WAAS 1 NE—Grand
‡MT. WAAS 1 SE—Grand

Vermont

ENOSBURG FALLS*[1]—Franklin
HYDE PARK*[1]—Lamoille
PLAINFIELD*[1]—Washington

Virginia

RICEVILLE*—Pittsylvania

Washington

AIRWAY HEIGHTS—Spokane
ANDERSON ISLAND—Pierce
BATTLE GROUND—Clark
BEVERLY—Grant
BEVERLY SE—Grant
BRUCE—Adams
FORT LEWIS—Pierce
FOUR LAKES—Spokane
LACKAMAS CREEK—Clark
NISQUALLY—Thurston
OMAK LAKE*—Okanogan
ROCHESTER—Thurston
STEILACOOM—Pierce
VANTAGE—Kittitas
WILDCAT LAKE—Kitsap

Wisconsin

ABBOTSFORD*—Clark
BELLEVUE—Brown
CLEVELAND—Manitowoc
DENMARK*—Brown
DE PERE*—Brown
FRANKLIN—Sheboygan
GREEN BAY*—Brown
GREEN BAY EAST—Brown
GREEN BAY WEST—Brown
HATLEY*—Marathon
HOWARDS GROVE—Sheboygan
MARATHON*—Marathon
NEW FRANKEN*—Brown
ST. WENDEL—Manitowoc
SCHOOL HILL—Manitowoc
SHEBOYGAN NORTH—Sheboygan
WAUSAU*—Marathon

Wyoming

ARTESIAN DRAW—Campbell
CHRISTINA LAKE—Fremont
HOUSE CREEK—Johnson
MINERS DELIGHT—Fremont
PINE TREE—Campbell
SAGE*—Lincoln
SEMINOE DAM—Carbon
T E RANCH—Carbon
WEISER PASS—Fremont
WOLF POINT—Fremont

In addition to the standard series of quadrangle maps, small-scale (1:250,000) maps of areas in the United States and Territories are being published and distributed. They may be purchased from the Geological Survey for 50 cents per copy. An index to the series is available on request.

Louisiana

SHREVEPORT

Louisiana-Mississippi

BATON ROUGE

Louisiana-Texas

LAKE CHARLES

Mississippi-Louisiana

JACKSON
NATCHEZ

SPECIAL MAPS

Set of one hundred topographic maps illustrating specified physiographic features, assembled by W. B. Upton, Jr. 1955. Price, $15 per set.
No discount.
This set of maps has been selected to illustrate a wide variety of well portrayed physiographic features. The set generally follows the Physical Divisions Map of the United States and illustrates most of its 86 subdivisions.

Set of twenty-five topographic maps illustrating specified physiographic features, assembled by W. B. Upton, Jr. 1955. Price, $5 per set.
No discount.
A smaller set arranged for those interested in a less detailed study than that of the 100-map set.

Lake Survey Charts

PUBLICATION of new editions of the following Lake Survey Charts has been announced by the United States Lake Survey of the Corps of Engineers, U. S. Army. Copies of these charts may be obtained from the U. S. Lake Survey, 630 Federal Building, Detroit 26, Mich., at 75 cents per copy. Payment is required in advance of P. O. money order or draft, payable to the Treasurer of the United States.

36.—Coast Chart. Vermilion, Ohio, to Port Clinton, Ohio, and Point Pelee, Ont., to Colchester, Ont., at 1:80,000 scale. (December 1955)

42.—Lake St. Clair. The entire lake including St. Clair River to Woodstick Island, at 1:60,000 scale (February 1956)

84.—Lake of the Woods. Southern part of the lake, south of Northwest Angle Inlet and west of Sabaskong Bay, Ont., at 1:120,000 scale. (December 1955)

346.—Fairport Harbor, Ohio, at 1:8,000 scale. (January 1956)

363.—Huron Harbor, Ohio, at 1:5,000 scale. (January 1956)

365.—Sandusky Harbor, Ohio, at 1:10,000 scale. (January 1956)

819.—Rainy Lake. Big Island, Minn., to Oak Point Island, Ont., at 1:25,000 scale, with inset of Kettle Falls, Minn., at 1:10,000 scale. (November 1955)

821.—Rainy Lake. Dryweed Island, Minn., to Big Island, Minn., at 1:25,000 scale. (December 1955)

823.—Rainy Lake. International Falls, Minn., to Dryweed Island, Minn., at 1:25,000 scale. (December 1955)

Publication of new editions of the following Minnesota-Ontario Border Lakes Charts has also been announced. These charts do not show hydrography. All are at 1:42,240 scale. Copies of these charts may be obtained from the address given above at 25 cents per copy.

806.—North Lake
807.—Northern Light Lake
808.—Sea Gull Lake
809.—Saganaga Lake
810.—Knife Lake
811.—Basswood Lake, Eastern Part
812.—Basswood Lake, Western Part
813.—Crooked Lake
815.—Lac la Croix
817.—Sand Point Lake to Lac la Croix including Crane Lake and Little Vermilion Lake
818.—Namakan Lake, Eastern Part
820.—Namakan Lake, Western Part and Kabetogama Lake, Western Part

Public Land Survey Plats

THE FOLLOWING plats of public land surveys and resurveys were completed and accepted by the Bureau of Land Management between December 1, 1955 and February 29, 1956. The class or purpose of the survey is indicated. Copies of plats may be secured from the Bureau Offices in the States or from the Director, Bureau of Land Management, Department of the Interior, Washington 25, D. C.

Alaska—Fairbanks Meridian

T. 11 S., R. 10 E.—original survey
T. 12 S., R. 10 E.—(3 plats)—original survey
T. 10 S., R. 11 E.—original survey
T. 11 S., R. 11 E.—original survey

Arizona—Gila and Salt River Meridian

T. 2 N., R. 12 W.—skeleton survey
T. 1 N., R. 13 W.—skeleton survey
T. 3 N., R. 13 W.—skeleton survey
T. 4 S., R. 21 E.—skeleton survey
T. 4 S., R. 22 E.—skeleton survey
T. 6 S., R. 27 E.—skeleton survey
T. 5 S., R. 28 E.—skeleton survey
T. 6 S., R. 28 E.—skeleton survey
T. 6 S., R. 29 E.—skeleton survey
T. 1 S., R. 14 W.—skeleton survey

California—Mt. Diablo Meridian

T. 32 N., R. 9 W.—resurvey and subdivisional

California—San Bernardino Meridian

T. 16 N., R. 6 E.—skeleton survey
T. 16 N., R. 7 E.—skeleton survey
T. 16 N., R. 8 E.—skeleton survey

Idaho—Boise Meridian

T. 5 N., R. 4 E.—dependent resurvey
T. 43 N., R. 10 E.—original survey
T. 44 N., R. 10 E.—original survey
T. 9 S., R. 27 E.—dependent resurvey
T. 11 S., R. 27 E.—dependent resurvey
T. 9 S., R. 28 E.—dependent resurvey

Michigan—Michigan Meridian

T. 43 N., R. 16 W.—island surveys
T. 47 N., R. 16 W.—island surveys
T. 39 N., R. 19 W.—island surveys
T. 39 N., R. 20 W.—island surveys
T. 58 N., R. 29 W.—island surveys
T. 58 N., R. 30 W.—island surveys
T. 6 S., R. 8 E.—subdivision of sections
T. 7 S., R. 8 E.—subdivision of sections

Minnesota—Fourth Principal Meridian

T. 68., R. 18 W.—island surveys
T. 49 N., R. 22 W.—island surveys

Montana—Principal Meridian

T. 3 S., R. 3 W.—extension survey

Nebraska—Sixth Principal Meridian

T. 15 N., R. 10 W.—amended resurvey
T. 20 N., R. 21 W.—dependent resurvey
T. 21 N., R. 22 W.—dependent resurvey

Nevada—Mt. Diablo Meridian

T. 15 N., R. 21 E.—extension survey
T. 20 N., R. 18 E.—resurvey, part of subdivision
T. 7 N., R. 60 E.—resurvey, part of boundaries
T. 8 N., R. 61 E.—resurvey, part of boundaries
T. 9 N., R. 61 E.—resurvey, part of boundaries
T. 10 N., R. 61 E.—resurvey, part of boundaries
T. 21 S., R. 60 E.—dependent resurvey
T. 22 S., R. 60 E.—dependent resurvey
T. 5 S., R. 68 E.—original survey
T. 8 S., R. 68 E.—original survey
T. 6 S., R. 69 E.—survey, part of boundaries
T. 8 S., R. 69 E.—survey, part of boundaries
T. 2 S., R. 70 E.—resurvey, part of boundaries
T. 6 S., R. 70 E.—survey, part of boundaries
T. 7 S., R. 70 E.—survey, part of boundaries
T. 8 S., R. 70 E.—survey, part of boundaries
T. 8½ S., R. 71 E.—original survey
T. 9 S., R. 70 E.—original survey
T. 10 S., R. 70 E.—original survey
T. 11 S., R. 70 E.—resurvey, part of boundaries
T. 12 S., R. 70 E.—resurvey, part of boundaries
T. 2 S., R. 71 E.—resurvey, part of boundaries
T. 7 S., R. 71 E.—survey, part of boundaries
T. 8½ S., R. 71 E.—original survey
T. 9 S., R. 71 E.—original survey
T. 10 S., R. 71 E.—original survey

New Mexico—New Mexico Principal Meridian

T. 11 N., R. 3 W.—resurvey, part of subdivisions
T. 12 N., R. 3 W.—resurvey, part of subdivisions
T. 3 N., R. 5 W.—dependent resurvey

North Dakota—Fifth Principal Meridian

T. 147 N., R. 99 W.—dependent resurvey
T. 148 N., R. 99 W.—dependent resurvey
T. 147 N., R. 100 W.—dependent resurvey
T. 148 N., R. 100 W.—dependent resurvey

South Dakota—Fifth Principal Meridian

T. 115 N., R. 62 W.—dependent resurvey
T. 116 N., R. 62 W.—dependent resurvey
T. 114 N., R. 63 W.—dependent resurvey
T. 115 N., R. 63 W.—dependent resurvey
T. 116 N., R. 63 W.—dependent resurvey
T. 114 N., R. 64 W.—dependent resurvey

Wisconsin—Fourth Principal Meridian

T. 32 N., R. 14 E.—island survey

Wyoming—Sixth Principal Meridian

T. 43 N., R. 64 W.—dependent resurvey
T. 44 N., R. 64 W.—dependent resurvey
T. 43 N., R. 65 W.—dependent resurvey
T. 44 N., R. 65 W.—dependent resurvey
T. 46 N., R. 65 W.—dependent resurvey
T. 46 N., R. 66 W.—dependent resurvey
T. 34 N., R. 96 W.—dependent resurvey
T. 33 N., R. 97 W.—dependent resurvey
T. 34 N., R. 97 W.—dependent resurvey
T. 32 N., R. 98 W.—dependent resurvey
T. 33 N., R. 98 W.—dependent resurvey
T. 34 N., R. 98 W.—dependent resurvey
T. 46 N., R. 92 W.—subdivision of sections
T. 46 N., R. 93 W.—(2 plats)—subdivision of sections

T. 58 N., R. 98 W.—subdivision of sections
T. 54 N., R. 100 W.—subdivision of sections
T. 55 N., R. 100W.—(4 plats)—subdivision of sections
T. 53 N., R. 101 W.—subdivision of sections
T. 54 N., R. 101 W.—subdivision of sections
T. 55 N., R. 101 W.—(4 plats)—subdivision of sections

Wyoming—Wind River Meridian
T. 3 N., R. 1 W.—subdivision of sections

Foreign Topographic Mapping Agencies and their Sales and Information Offices

This list of addresses of foreign agencies engaged in topographic mapping and the addresses of their sales-and-information offices was compiled by William Hannah, 2601 E. Helen St., Tucson, Ariz., with the following purposes in mind:

(1) To provide members of ACSM and readers of SURVEYING AND MAPPING with accurate and up-to-date addresses for correspondence and ordering, and

(2) To provide those traveling overseas with the means of saving time, money, and effort in locating and visiting show-room and sales offices in the various countries.

It is hoped that, through the cooperation of Mr. Hannah, the additions to this list and the revisions necessary to keep the list up to date may become a regular feature of our MAP INFORMATION department.

—EDITOR

MAP SALES AND INFORMATION COUNTERS	GOVERNMENT TOPOGRAPHIC MAP AGENCIES
ARGENTINA Sección Ventas del Instituto Geográfico Militar Calle Azopardo No. 250 BUENOS AIRES	Dirección General del Instituto Geográfico Militar Cabildo 381 BUENOS AIRES
AUSTRALIA National Mapping Office Department of the Interior CANBERRA, A.C.T.	Same
AUSTRIA Bundesamt fuer Eich- und Vermessungswesen (Landesaufnahme) Krotenthallergasse 3 WEIN VIII	Same
BELGIUM Institut Géographique Militaire Dépôt des Cartes Place des Carabiniers (Tir National) BRUSSELS	Institut Géographique Militaire 2, allée du Cloître BRUSSELS
CANADA Map Distribution Office Department of Mines and Technical Surveys OTTAWA, Ontario	Department of Mines and Technical Surveys Topographical Survey Division Number 8 Temporary Building Carling Avenue OTTAWA, Ontario
CEYLON Surveyor General's Office Lower Chatam Street COLOMBO 1	Same

COLOMBIA, S. A. Instituto Geográfico de Colombia "Augustín Codazzi" BOGATA	Same
COSTA RICA, C. A. Instituto Geográfico de Costa Rica Apartado 2272 SAN JOSE	Same
DENMARK Geodaetisk Institut Proviantgaarden COPENHAGEN K.	Same
DOMINICAN REPUBLIC Instituto Topográfico Militar Secretaría de Estado de las Fuerzas Armadas CIUDAD TRUJILLO	Same
ECUADOR, S. A. Instituto Geográfico Militar Calle Ambato No. 328 QUITO	Same
EGYPT[1] Director General Survey Department EL GIZA (Orman)	Same
EL SALVADOR, C. A.[1] Dirección General de Cartografia Ministerio de Obras Publicas SAN SALVADOR	Same
FINLAND Maanmittaushallituksen Kartanmyynti Malminrinne 3 HELSINKI	Maanmittaushallitus Topografinen toimisto Kirkkokatu 3 HELSINKI
FRANCE Service de Vente Institut Géographique National 107, Rue La Boétie PARIS 8e.	Direction Générale Institut Géographique National 136 bis, Rue de Grenelle PARIS 7e.
GREAT BRITAIN Messrs. E. Stanford Ltd. 12/14 Long Acre LONDON W.C.2.	Ordnance Survey Office Leatherhead Road CHESSINGTON, Surrey
GREECE[1] Commanding Officer Greek Army Geographical Service ATHENS	Same
GUATEMALA, C. A. Dirección General de Cartografia GUATEMALA	Same
HAITI Service de Gédésie & de Cartographie Boulevard Harry Truman Cité de l'Exposition PORT-AU-PRINCE	Same

[1] Maps are classified material; no sales are made to private persons without prior authorization.

HONDURAS, C. A.	
Comision Geografica Especial del Ministerio de Fomento TEGUCIGALPA, D. C.	Same
ICELAND	
Sigfús Eymundsson Bookstore REYKJAVIK	Government Surveying Department The State Engineer's Office REYKJAVIK
IRELAND	
Assistant Director Ordnance Survey Office Phoenix Park DUBLIN	Same
ISRAEL	
Department of Surveys Lincoln Street No. 1 P.O.B. 2730 TEL-AVIV	Same
ITALY	
Instituto Geografico Militare Sezione Vendita Viale F. Strozzi 6-14 FIRENZE	Institut Geografico Militare Divisione Geografica Via Cesare Battisti 10 FIRENZE
JAPAN	
Buyō-Dō 3-1, Nihonbashi-dōri Chuo-ku TOKYO	Geographical Survey Institute Ministry of Construction 241, Kurosuna-cho CHIBA CITY
LUXEMBOURG	
Administration du Cadastre de Luxembourg 54, avenue Gaston Diderich LUXEMBOURG CITY	None (*A complete mapping program was executed chiefly by the Institut Géographique National of France, so commissioned by the Luxembourg government.*)
NETHERLANDS	
Afdeling Kaartverkoop Topografische Dienst Westvest 9 DELFT	Topografische Dienst Westvest 9 DELFT
NEW ZEALAND	
The Surveyor-General Department of Lands and Survey WELLINGTON	Same
NORWAY	
Norges geografiske oppmåling St. Olavsgate 32 OSLO	Same
PANAMA, REPUBLIC OF[2]	
Oficina de Cartografia Avenida España 16 PANAMA	Same
PHILIPPINES	
Bureau of Coast and Geodetic Survey 77 Barraca Street Binondo MANILA	Same

2 For purchase of restricted maps of Panama and Canal Zone, prior authorization is required from Col. Robert R. Robertson, Director, Inter-American Geodetic Survey, BALBOA, Canal Zone.

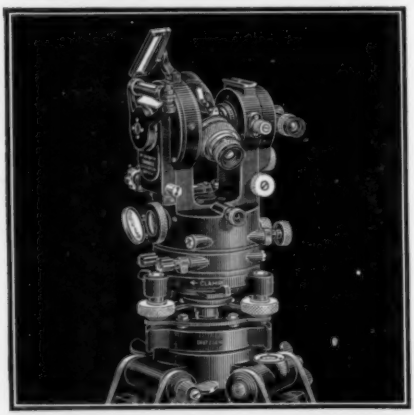
POLAND	
Prasa i Ksiazka 18, Foksal Street WARSAW	Panstwowe Przedsiebiorstwo Wydawnictw Kartograficznych 18, Solec Street WARSAW
SWEDEN	
Generalstabens litografiska anstalt Vasagatan 16 STOCKHOLM 1.	Rikets allmänna kartverk Hantverkargatan 29 STOCKHOLM K.
SWITZERLAND	
Abteilung für Landestopographie Seftigenstrasse 264 WABERN b. BERN	Same
SYRIA	
Service de Vente Institut Géographique National 107, Rue La Boétie PARIS 8e., France	Ministry of National Defense Map Division G-3 DAMASCUS
TURKEY	
Turkish Geodetic Survey Harita Umum Müdürlüğü ANKARA	Same
UNION OF SOUTH AFRICA	
Publications Section Government Printing and Stationery Department Bosman Street PRETORIA	Trigonometrical Survey Office PRETORIA
VENEZUELA	
Dirección de Cartografía Nacional Quinta Santa Inés Caño Amarillo a Estación CARACAS	Same
WEST GERMANY (*Decentralized into the following nine regional agencies*)	
Landesvermessungsamt Baden-Württemberg Charlottenplatz 17 STUTTGART-S.	Same
Bayerisches Landesvermessungsamt Alexandrastrasse 4 MUNICH 22	Same
Hessiches Landesvermessungsamt Riederbergstrasse 39 WIESBADEN	Same
Niedersächsisches Landesvermessungsamt Heinrichstrasse 11 HANNOVER	Same
Landesvermessungsamt Nordrhein-Westfalen Beethovenstrasse 27/29 BAD GODESBERG	Same
Landesvermessungsamt Schleswig-Holstein Mecklenburgerstrasse 12–16 KIEL-WIK	Same
Landesvermessungsamt für das Land Rheinland-Pfalz Hochhaus KOBLENZ	Same

Vermessungsamt Hamburg Steckelhörn 12 HAMBURG 11	Same
Kataster- und Vermessungsverwaltung Bürenstrasse 19 BREMEN	Same
YUGOSLAVIA[1]	
Topographic Institute of Yugoslavia c/o Odeljenje za Stampu Kneza Milosa 26 BELGRADE	Same

—WILLIAM HANNAH

Earth on a Diet?

We have been hearing frequently, for a good many years now, that "the earth is getting smaller all the time," but now the Army Map Service has made it official. Bernard Chovitz, an Army Map Service mathematician, reported to the Section of Geodesy at the annual meeting of the American Geophysical Union, in Washington, D. C., May 2, 1956, that a recent study has shown that the earth's waistline (equatorial circumference) is now believed to be just about ½ mile less than the previously accepted figure. This is roughly 1 part in 50,000. A man with a 40-inch waistline would be required to tighten his belt less than 0.001 inch to take up the slack if he "reduced" in the same proportion.



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Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the CONGRESS. It is the purpose of this Department to encourage comments on published material or the presentation of new ideas in an informal way.
—EDITOR

STANDARDS FOR SURVEY MONUMENTS AND LEGAL DESCRIPTIONS

WILLIAM PRICE*—Our Country is developing rapidly and the value of property is increasing at an equal, if not faster, pace. The location of property and boundary lines is more important than ever.

Perhaps the most important legal principle concerning the relocation of property lines is that original monuments cannot be disputed when there is sufficient evidence to identify the monuments and show that they have not been disturbed. The land surveyor is daily confronted with the problem of deciding whether the monuments that he finds on retracement surveys are original corners or not. Every surveyor knows that this problem is a serious one. The monuments set, in perhaps the majority of original surveys, were not of a permanent nature and were not properly described or shown on the map or the legal description of the property. The surveying profession should give serious consideration to this problem.

It would seem pertinent that some standards be established for monumenting property lines. There are, to my knowledge, no standards now. Each surveyor sets his own particular type of monument and is usually not consistent with this. The following suggestions might be considered:

Definite standards for monuments should be established within a particular geographical or political area. It would seem most practical to have the geographical area the same as that which is controlled by one political government. In California this would be by Counties, because all records pertaining to land ownership and all recorded maps are recorded in the office of the County Recorder.

A definite set of standards could be established for the several different types of surveys. Control surveys and surveys which establish new property lines from which legal descriptions are written would be one standard. These would also include the monuments set on the retracement of boundaries when said retracement survey is shown on a map to be recorded. A different set of standards could be used for the replacement of lot corners in a legal subdivision that is shown on a map of record.

Regarding the physical material used for the monument, it is obvious that some tolerance should be provided, so that the monument used could be the best for physical conditions existing at that particular location. Emphasis should be placed on the permanence of the monument.

The manner of marking or inscribing the monuments so they may be identified is as important as the physical properties of the monument itself. Perhaps reference to the record map, deed, or the legal document could be placed on the monument.

There has been a great deal of publicity and discussion concerning the use of the State's coordinate system which is, undoubtedly, a worthwhile system. However, the majority of the land boundaries that the surveyor is concerned with are boundaries that have been previously surveyed, and, as mentioned previously, the original monuments of these lines cannot be disputed. It is the surveyor's job to relocate these lines as they were originally established, and the State's coordinate points certainly are of little, if any, help in this regard. It would seem of even more importance than ties to the State's system, that standard monuments of a permanent nature be set for original and replacement corners.

The complex problems arising from poorly

* General Petroleum Corporation, Bakersfield, Calif.

worded legal descriptions are well known to all surveyors. It would seem that, in line with the standardizing of monuments, there should be some requirement whereby it would be necessary to describe the monuments and make them the primary calls in legal descriptions. Certainly the physical boundaries of a piece of property and the legal description of record could be more closely related. The average property owner, whose property is described without the calls to specific monuments, has no idea as to the meaning of his description.

The American Congress on Surveying and Mapping, as the organization most influential in the surveying and mapping profession, should endeavor to promote standardization. The aid of the title and abstract companies would be helpful in improving the standards for legal descriptions. Perhaps some of the suggestions outlined above could be of some help.

ENCROACHMENT OF BUILDINGS

A. B. YEATS*—I forward to you a copy of "The Encroachment of Buildings Act of 1955."

I do this because, (*a*) The existence of this Act may not have been brought to your notice, and (*b*) The passing of this Act made a most important change to the local attitude towards encroachments.

By way of comment, it would seem that this Act might tend to weaken the absolute value of a freehold title; but it might, also, be a practical approach to such cases where a building (quite innocently on the part of the original builder) encroaches by a small amount on neighboring property.

I understand that, generally, it is attempted to have all titles as unchallengeable as possible. It would follow that the responsibility lies with an owner to see that his building does not encroach. It seems that this Act provides for an independent authority to arbitrate when it is found that an encroachment exists.

This matter is associated with *Property Surveys*, and I would be interested to know how this has been dealt with in other countries. Should you know of any relevant literature, I would be pleased to hear of it.

I trust that this Act is of interest to you, and I would be pleased to hear your comments thereon.

EDITOR'S NOTE:—The Act which accompanied the above letter is quoted below.

QUEENSLAND

An Act to make provision for the Adjustment of Boundaries where Buildings Encroach on Adjoining Land; To Facilitate the Determination of Boundaries; and for purposes connected therewith.

[ASSENTED TO 22ND APRIL, 1955]

Be it enacted by the Queen's Most Excellent Majesty, by and with the advice and consent of the Legislative Assembly of Queensland in Parliament assembled, and by the authority of the same, as follows:—

1. This Act may be cited as *"The Encroachment of Buildings Act of* 1955."

2. In this Act, unless the context or subject-matter otherwise indicates or requires, the following terms shall have the meanings respectively assigned to them, that is to say—

"Adjacent owner"—The owner of land over which an encroachment extends;

"Boundary"—The boundary line between contiguous parcels of land;

"Building"—A substantial building of a permanent character: The term includes a wall;

"Court"—The Supreme Court or a Judge thereof;

"Encroaching owner"—The owner of land contiguous to the boundary beyond which an encroachment extends;

"Encroachment"—Encroachment by a building, including encroachment by overhang of any part as well as encroachment by intrusion of any part in or upon the soil;

"Owner"—Any person entitled to an estate of freehold in possession—

(a) Whether in fee-simple or for life or otherwise;

(b) Whether at law or in equity;

(c) Whether absolutely or by way of mortgage, and includes a mortgagee under a registered mortgage of a freehold estate in possession in land under * *"The Real Property Acts, 1861 to* 1952";

"Subject land"—That part of the land over which an encroachment extends.

Encroachments.

3. (1.) Either an adjacent owner or an encroaching owner may apply to the Court for relief under this Act in respect to any encroachment.

* Authorized Surveyor, c/o Engineering Department, Toowoomba City Council, Toowoomba, Queensland, Australia.

* 25 V. No. 14 and amending acts.

(2.) On the application the Court may make such order as it may deem just with respect to—

(a) The payment of compensation to the adjacent owner;

(b) The conveyance, transfer, or lease of the subject land to the encroaching owner, or the grant to him of any estate or interest therein or of any easement, right, or privilege in relation thereto;

(c) The removal of the encroachment.

(3.) The Court may grant or refuse the relief or any part thereof as it deems proper in the circumstances of the case, and in the exercise of this discretion may consider amongst other matters—

(a) The fact that the application is made by the adjacent owner or by the encroaching owner, as the case may be;

(b) The situation and value of the subject land, and the nature and extent of the encroachment;

(c) The character of the encroaching building, and the purposes for which it may be used;

(d) The loss and damage which has been or will be incurred by the adjacent owner;

(e) The loss and damage which would be incurred by the encroaching owner if he were required to remove the encroachment;

(f) The circumstances in which the encroachment was made.

(4.) This section applies to encroachments made either before or after the commencement of this Act.

4. (1.) The minimum compensation to be paid to the adjacent owner in respect of any conveyance, transfer, lease, or grant as aforesaid to the encroaching owner shall, if the encroaching owner satisfies the Court that the encroachment was not intentional and did not arise from negligence, be the unimproved capital value of the subject land, and in any other case three times such unimproved capital value.

(2.) In determining whether the compensation shall exceed the minimum, and if so by what amount, the Court shall have regard to—

(a) The value, whether improved or unimproved, of the subject land to the adjacent owner;

(b) The loss and damage which has been or will be incurred by the adjacent owner through the encroachment and through the orders proposed to be made in favor of the encroaching owner;

(c) The circumstances in which the encroachment was made.

5. (1). The order for payment of compensation may be registered in the office of the Registrar of Titles in such manner as the Registrar of Title determines and shall, except so far as the Court otherwise directs, upon registration operate as a charge upon the land of the encroaching owner, and shall have priority to any charge created by him or his predecessor in title.

(2.) In this section the land of the encroaching owner means the parcel of land contiguous to the boundary beyond which the encroachment extends, or such part thereof as the Court may specify in the order.

6. Wherever the Court sees fit, and in particular where the encroaching owner is not an owner beneficially entitled to the fee-simple free from encumbrances, the Court may determine—

(a) By whom and in what proportions the compensation is to be paid in the first instance, and is to be borne ultimately;

(b) To whom, for whose benefit and upon what limitations the conveyance, transfer, or lease of the subject land or grant as aforesaid in respect thereof is to be made.

7. Wherever the Court sees fit, and in particular where the adjacent owner is not an owner beneficially entitled to the fee-simple free from encumbrances, the Court may determine—

(a) To whom, for whose benefit, and in what proportions the compensation is to be paid or applied; and

(b) By whom the conveyance, transfer, or lease of the subject land or grant in respect thereof is to be made.

8. Wherever the Court may make or has made an order under this Act with respect to the subject land, the Court may make such vesting order as it may deem proper in lieu thereof or in addition thereto, or in default of compliance therewith.

Boundaries.

9. (1.) Where any question arises as to whether an existing building encroaches or a proposed building will encroach beyond the boundary, either of the owners of the contiguous parcels of land may apply to the Court for the determination under this Act of the true boundary.

(2.) On the application the Court may make such orders as it may deem proper for determining, marking, and recording the true boundary.

(3.) This section applies to buildings erected either before or after the commencement of this Act.

General.

10. (1.) In any suit or proceeding before the Court, however originated, the Court may, if it sees fit, exercise any of the powers conferred by this Act, and may stay the suit or proceeding on such terms as it may deem proper.

(2.) Where any action or proceeding is

taken or is about to be taken at law by any person, and the Court is of the opinion that the matter could more conveniently be dealt with by an application under this Act, the Court may grant an injunction, on such terms as it may deem proper, restraining the person from taking or continuing the action or proceedings at law.

(3.) In any action at law a Judge may, if he is of the opinion that the matter could more conveniently be dealt with by an application under this Act, stay the action or proceeding on such terms as he may deem proper.

11. Until otherwise prescribed by Rules of Court, any application under this Act may be made by originating summons.

12. In any application under this Act the Court may require—

(*a*) That notice of the application shall be given to any person interested;

(*b*) That any person interested shall be made a party to the application.

13. In any application under this Act of Court may make such order as to the payment of costs, charges, and expenses as it may deem just in the circumstances and may take into consideration any offer of settlement made by either party.

14. (1.) All such Rules of Court as may be deemed necessary or convenient for regulating the practice and procedure of the Court for the purpose of giving full effect to this Act may be made and the provisions of * *"The Supreme Court Act of* 1921," and † *"The Supreme Court Acts Amendment (Rules Ratification) Act of* 1928," shall apply and extend in respect of such Rules of Court.

(2.) The practice and procedure of the Court shall, except so far as inconsistent with this Act or any Rules of Court, apply to application under this Act.

* 12 G. 5 No. 15.
† 19 G. 5 No. 3.

VICTOR H. GHENT*—Reference is made to your letter of April 3 [1956] regarding * * * and the Australia encroachment act.

* * * * *

Regarding the encroachment act (returned herewith), it appears, from a brief rundown and sorting through the legal terms, to be just about what the practice would normally be for such a case here. In other words, if a case here cannot be settled out of court, it would be up to the judge or jury to decide the damage and compensation thereof, the transfer of or lease of the subject encroachment or the removal thereof.

I would be interested in reviewing some of the comments on the article, if that can be conveniently arranged.

* Secretary, Property Surveys Division, ACSM.

A CORRECTION

MILTON O. SCHMIDT*—I wish to offer the following comment on the article "State Laws Defining Land Surveying" by Victor H. Ghent that appeared in the January–March 1956 issue of the Journal.

On page 19 of Mr. Ghent's article, footnote 7 reads in part as follow—"All states noted allow from two to four years of college toward experience requirements."

This is definitely not true for the State of Illinois. No credit is given for college training. The present law to all intents and purposes recognizes no intellectual benefits at all as deriving from graduation in Civil Engineering at an accredited institution.

* Professor of Civil Engineering, University of Illinois.

Kentucky Leads in Modern Map Coverage

Kentucky is celebrating completion of a $6,360,000 cooperative mapping program with the U. S. Geological Survey that has placed that State ahead of all others as the best-mapped State in this country.

The new mapping, accomplished at a scale of 1:24,000, completely covers the entire State. Twelve other States have complete map coverage but only Massachusetts, Rhode Island, and Connecticut have anywhere near as large a percentage of their area covered by modern mapping.

Some 780 quadrangle maps were needed to cover Kentuckey's 40,395 square miles. The work was accomplished through cooperation with the Kentucky Agricultural and Industrial Development Board, the State appropriating $3,180,000. This amount was matched dollar-for-dollar by the Federal Government.

News of Related Organizations

Virginia Association of Surveyors

The Eighth Annual Meeting of the Virginia Association of Surveyors was held on February 18 at historic Williamsburg, Va., with over 80 surveyors and ladies in attendance. The meeting opened with a welcome from City Manager Hugh Rice, followed by the report of the secretary-treasurer Dan Maher, whose records indicated membership for VAS was 130. Reports followed from the Northern Virginia Chapter and the Central Virginia Chapter and, from these reports, the main discussions of the day stemmed, as follows:

1. Attempts were being made to limit surveyors to only property-line work by stopping them from doing their long-established work of plans and profiles and minor drainage structures in connection with the proper subdivision of land. Mr. Hellwig, President, Northern Virginia Chapter, noted that attorneys had been working on the matter and that a hearing before the State Examing Board would probably take place in June. Mr. Ghent reported that the 1946 Virginia subdivision enabling act set forth certain requirements that counties could enact for subdivision control and that the act noted that *all* such plats required under the act must be prepared by a licensed land surveyor or civil engineer. He also read the definitions for land surveying in surrounding States, and it was noted that, by and large, most of these States recognize all subdivision work as part and parcel of the proper function of land surveyors. He also noted that preexamination requirements in Virginia were just about the lowest of all of those States that have licensing laws.

2. Directly opposed to attempts to strengthen the requirements for examinations, was a bill, believed to be about ready to be introduced into the current State legislative meeting, to abolish the whole registration act and reenact it with a year "grandfather" clause. This had been brought on by the lack of qualified land surveyors in certain rural sections of the State. This proposal apparently had the backing of many high State officials. A long discussion followed on this matter and included a report on the subject by one of the State Examining Board members. VAS moved that it and its members do their utmost to defeat this bill if and when it was introduced. (Note: The bill was not introduced at the regular session of the State Legislature; however, it may possibly be introduced at a special session which may be called in September.)

3. The Northern Virginia Chapter introduced a discussion on establishing associate or junior memberships in VAS. At present the only types of memberships available are voting memberships, which are restricted to licensed land surveyors, and affiliate memberships, which are limited to manufacturer's representatives. Pros and cons were heavy, and a motion to *not* open the membership was defeated by one vote. A motion was then made to have the VAS directors consider the matter, and, if they deemed it advisable to open the membership to nonregistered persons, to recommend the type of program and the persons who would come under it (much discussion evolved around the use of the words associate, junior, student, etc.).

Other business of the meeting included a resolution presented by Cecil Cross, President of the Northern Virginia Chapter of the Virginia Society of Professional Engineers and long a member of VAS. The resolution was passed by VAS. It states "That the Virginia Association of Surveyors concurs with the Virginia Society of Professional Engineers in endorsing the general promotion of the use of the Virginia State Plane Coordinate System, and that a joint letter be sent by the said Association and Society to the appropriate person or body in each political subdivision of the State, and to the Virginia State Highway Commission, advising them of this action and recommending full use of the system in those areas where such control is available. (Present Virginia law gives permissive use of the system where primary control is within ½ mile of the area for which it is desired to use the control for record purposes.)

It was also voted that the incoming president appoint a committee to work with officials of the Jamestown celebration of 1957 with the idea of setting aside one day for recognition of the surveying profession, and a committee to work with William and Mary College with the idea of compiling a history of the surveying profession for the State of Virginia. Dr. Earl G. Swem, Librarian Emeritus of the College of William and Mary, addressed the group in re-

gard to the forthcoming celebration and noted the part that surveying had played in the lives of so many famous men in American history. George Washington, for instance, received his license to practice surveying from William and Mary College, which college was the only one empowered at the time to issue such a license as being from the Surveyor-General of England.

The session ended with the annual banquet, at which time the outgoing President, C. V. Carlisle, turned the meeting over to the newly elected President, Al Cherry. Other new officers are Vice-President, John Marshall; Secretary-Treasurer, Charles Townes; and two-year Director, Robert Bartenstein. Many exhibitors enhanced the attractiveness of the meeting and many prizes were contributed for the banquet, including a new transit which was won by H. Hutton. Also, at the dinner, the past-presidents of the Association were presented with placques in recognition of their services.

—Victor H. Ghent
Director VAS

Welcome to Denver

1956 ACSM-ASP CONVENTION *and* CO-EXHIBIT

Shirley-Savoy Hotel, Denver, Colorado
September 30 — October 2, 1956

For further information contact:
STANLEY M. BORRELL, CONVENTION CHAIRMAN
Box 1407, Edgewater Branch, Denver 14, Colo.

CONGRESS NEWS

Louisiana Section

The Louisiana Section of the American Congress on Surveying and Mapping assembled for their annual dinner meeting on April 2, 1956, in the Engineers Club, DeSoto Hotel, New Orleans, La.

Members and visitors gathered for an informal social get-together from 6:45 to 7:15 p.m. An excellent dinner was served at 7:15 p.m., with 91 members and guests in attendance.

Chairman Jack S. Toler called the meeting to order at 8:35 p.m. Treasurer George E. Jones gave a report on the financial condition of the Section and reported a total of 92 members paid up. S. P. Chapman reported briefly on the activities at the National Convention in Washington.

Mr. Chapman introduced Roy T. Sessums, Assistant to Vice President and Engineering Coordinator of Freeport Sulphur Company. Mr. Sessums presented a talk in which he expressed the need for sound surveying principles. He gave a chronological review of surveying in the United States and in Louisiana, placing particular emphasis on the Louisiana phase of surveying and the problems involved.

Chairman Toler then announced and introduced the following newly elected officers and directors:

Martin Standard, *Chairman*
George E. Jones, *First Vice Chairman*
C. E. Bridges, *Second Vice Chairman*
George Mott, *Third Vice Chairman*
E. M. Sanders, *Secretary*
R. C. Dayton, *Treasurer*

Directors

C. H. Fenstermaker, Jr. 1956–1958
T. Baker Smith 1956–1958
A. A. Glodt[1] 1956–1957
Frank Ritchie[2] 1956–1957

H. M. Mayne has the remainder of his term to serve as Director.

Martin Standard, the newly elected chairman, spoke briefly and expressed his belief that the Section would promote and support many worthy causes in the coming year.

The meeting was brought to a close at 10:15 p.m.

—Robert Baker, Jr.
Section Editor

[1] To fill the unexpired term of R. C. Dayton.
[2] To fill the unexpired term of Robert Earle.

MARTIN STANDARD, NEWLY ELECTED CHAIRMAN OF THE LOUISIANA SECTION OF ACSM, ADDRESSING THE SECTION AT ITS ANNUAL DINNER MEETING ON APRIL 2, 1956, AT NEW ORLEANS, LA.

Northern California Section

More than 150 surveyors of the northern California area this spring attended a 25-hour course of instruction on "Description and Survey in Title," cosponsored by the University of California's Engineering Extension Division and the Northern California Section of ACSM. The instructor for the course was none other than ACSM's national vice president, William C. Wattles, who journeyed the 400 miles from Los Angeles to the San Francisco area to present the course on alternate week ends. Some of those attending traveled nearly 150 miles.

The large enrollment in this course, the most recent in more than a half-dozen on various surveying subjects sponsored by the Section, points up the interest of ACSM members in advancing their status as professional men. Because of this interest, the Northern California Section considers it to be a part of its responsibility as a professional society to not only publicize courses of possible interest to its members but also to obtain courses desired or needed by them.

—C. A. Wooldridge, Jr.
Chairman, Membership Committee
Northern California Section

Colorado Section

Plans are taking shape for the fall meeting in Denver. Convention Chairman Stanley M. Borrell and Committee Chairmen Collins, Kelly, Parker, and Upton are completing the program for the meeting. This joint convention and coexhibit, sponsored by the local sections of the American Congress on Surveying and Mapping and the American Society of Photogrammetry, is being held September 30th through October 2nd. A reception Sunday afternoon, September 30th, at the Shirley-Savoy Hotel, official headquarters for the convention, will open the meeting.

Convention Program Chairman Thomas A. Kelly has invited an outstanding panel of speakers to present the latest developments in the fields of surveying, photogrammetric mapping, and related subjects. Scenic trips are being arranged to nearby mountain areas, as well as tours of two local Federal installations. At Lowry Air Force Base the photographic unit and photographic planes will be on exhibit. At the Federal Center, the Geological Survey's Topographic Division mapping unit will display field and office instruments, and will also show delegates a large stero-compilation unit engaged in mapping areas in Alaska and the Rocky Mountain region.

Excellent space has been secured at the Shirley-Savoy Hotel for technical sessions, exhibits of instruments and equipment, and for the Sunday reception. The banquet to be held there on October 2nd closes the meeting. Arrangements have been made with the hotel to handle all out-of-town reservations.

The complete program for the meeting, furnishing information on the schedule of speakers and their topics, rates for registration, scheduled events, and hotel rooms, will be mailed in ample time to the entire memberships of both national organizations. Inquiries may be addressed to Convention Chairman S. M. Borrell, Box 1407, Edgewater Branch, Denver 14, Colorado.

—Wm. B. Upton, Jr.
Section Editor

Texas Section

Fifty-five members and eleven guests were present for the twentieth meeting of the Texas Section on March 28, 1956. Out-of-town guests were present from Wichita Falls, Midland, Corpus Christi, and Tyler, Texas, and New Orleans, Louisiana. Chairman J. A. Tomlinson presided at this first meeting of 1956.

W. H. Wilson, Chairman of the Constitution and By-Laws Committee, reported on the proposed changes in the Constitution and By-Laws. He stated that he had discussed the proposed changes with the Board of Directors in Washington, and that the amendments were ready to be submitted to the members of the Texas Section.

Wm. F. Sullivan, Chairman of the Program Committee, had arranged a fine program of three informative papers:

"Short-Cut Calculating Machine Method of Computing the P.I. of Two Lines," by Wm. F. Warfield.

"Equations for Computing the P.I. of Two Lines," by Hodge E. Mason.

"The 1956 National Convention," by R. L. Sargent, Immediate Past Chairman, Texas Section.

—Hodge E. Mason
Editor, Texas Section

U. S. Vice President Nixon Presents S.A.M.E. Gold Medal

At a dinner at the Army Map Service on Monday night, May 14, 1956, United States Vice President Richard M. Nixon made the presentation of the Society of American Military Engineer's gold medal "for distinguished service" to Eugene A. McGovern of Rockville Centre, N. Y. The occasion was an event of the S.A.M.E. 36th Annual Meeting in the Washington area. Earlier in the day at Fort Belvoir, Va., Rear Admiral Robert H. Meade, Chief of the Navy's Bureau of Yards and Docks, addressing members of the Society, made a point of the example in cooperation rather than rivalry being set by the engineers of the three major branches of the military service—Army, Navy, and Air Force. Major General James B. Newman, Jr., is the new president of S.A.M.E.

Plane Coordinate Intersection Tables

The Coast and Geodetic Survey, Department of Commerce, has published two more of the series of plane coordinate intersection tables. These latest publications are:

Rhode Island—Special Publication No. 342,

Vermont—Special Publication No. 343,

and each contains X and Y coordinates of each 2½-minute intersection within the limits of the State. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at the following prices: S.P. 342, 15 cents, S.P. 343, 25 cents.

Personals

Talbert Abrams, President of Abrams Aerial Survey Corporation, has announced that at the annual meeting of the Board of Directors of that corporation a number of changes involving members of ACSM were made. **W. S. Karr** was elected Executive Vice President; **Ralph E. Kauffman** has been made Vice President in charge of sales; and **Elmore Kerkela** is now Vice President and Manager.

Quentin S. Johnson, member of ACSM and an Assistant Editor of SURVEYING AND MAPPING, was one of eighteen engineers and scientists from the Engineer Research and Development Laboratories, Fort Belvoir, Va., who substituted for teachers who attended the National Science Teachers Association Convention in Washington, D. C., on March 15 and 16, 1956.

Captain **Clarence A. Burmister,** Coast and Geodetic Survey, retired from the service on May 1, 1956. At the time of his retirement he was Chief of the Radiosonic Laboratory, having held that position since 1946. In 1951 he received the Department of Commerce Silver Medal and in 1955 the Gold Medal—the first man in the history of the Bureau to receive both of these awards.

William E. Wrather, recently retired Director of the U. S. Geological Survey and member of ACSM, was awarded the Sidney Powers gold medal at the meeting of the American Association of Petroleum Geologists in Chicago, April 23–26, 1956.

ACSM member Dr. **Lewis V. Judson,** Chief of the Length Section of the Optics and Metrology Division of the National Bureau of Standards, has received the Department of Commerce Silver Medal for Meritorious Service. The award was given in recognition of Dr. Judson's "extremely competent performance for 38 years in the field of length standards and precise length determinations."

Dr. Judson is custodian of the National Standard of Length. In addition he is in charge of calibrations of measuring tapes and precise leveling rods; graduation and calibration of precision circles; research in thermal expansion of solids; interferometry in length measurements; and many other phases of the work involving the calibration of devices for length measurements.

ACSM Recommends Good Maps and Surveys As Good Investment Here

The U. S. Department of Commerce discloses that nearly one billion dollars a year for the next twenty years needs to be spent on the country's water supply systems to ease water shortages and cope with rapidly expanding needs. It was estimated that approximately thirteen billion dollars in new capital investment will be required by 1975 to keep pace with increasing population and its corresponding steady rise in water usage. This estimate is based on a total population of 206,600,000 by 1975.

Six billion dollars is declared needed to bring outdated water supply systems to the degree of adequacy of 1940 because of construction lags which occurred during restrictive periods of World War II and the Korean War while population and needs for water increased as usual. Indicating its projection of water needs over the next twenty years as conservative with respect to population to be served and volume of water to be used, the Commerce Department study further reflected that approximately 80 percent of the nation's water work utilities are publicly owned and operated.

Projecting plans and estimates for such studies as above requires a great deal of factual information and intelligence data. The actual engineering and construction of projects requires very much more comprehensive information—facts and more facts. Maps and surveys are documents of comprehensive information. The very best and latest maps and surveys obtainable are very wise insurance in underwriting the wise expenditure of large amounts of money for any venture of this type. Maps and surveys are the X-rays for professionally engineered projection planning—maps and surveys are the basic blueprints for project design.

—WALTER S. DIX

Executive Secretary, ACSM

Lyddan Named Assistant Director for USGS

The appointment of Robert H. Lyddan as Assistant Director of the Geological Survey was announced May 7, 1956.

Mr. Lyddan was born in Irvington, Ky., December 3, 1910; graduated from the University of Kentucky as a civil engineer in 1931; served with the Interstate Commerce Commission from 1931 to 1933; and then joined the Geological Survey. Until 1946 he was engaged in a variety of topographic mapping activities at several different locations in the United States, Alaska, and Puerto Rico.

From 1947 to 1955 he served as chief of the Plans and Coordination Branch of the Atlantic Region office. From 1955 until his appointment as assistant director he held the post of Regional Engineer of the Atlantic Division, with headquarters in Arlington, Va.

He served as chairman of the Surveying and Mapping Division of the American Society of Civil Engineers, is a director of ACSM, is a past president of the Washington Society of Engineers, and is a member of the American Society of Photogrammetry and the Society of American Military Engineers.

Albert B. Hoen

Albert B. Hoen died May 1, 1956, at the age of 92 years. He was, before his retirement, president of the oldest lithographing company in the United States. His lifelong association with the firm of A. Hoen & Co., Baltimore, Md., founded in 1835, won for him international recognition as a mapmaker. The firm of A. Hoen & Co., lithographs the map supplements which come now and then with the *National Geographic Magazine*.

Empire Survey Review Celebrates Its Silver Jubilee

The April 1956 issue of the *Empire Survey Review* is "No. 100" and, because that journal is a quarterly, this means that the *Review* is now in its 26th year. Congratulations!

On pages 242 and 243 of that issue there appears a brief but very interesting review of the origin, development, and growth of this excellent British journal.

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Rannie Township

John L. Rannie, well known to many members of ACSM, has been honored posthumously by having a new township in the Province of Quebec named for him. The decision of the Quebec Government to name the new township for Mr. Rannie was communicated to the Canadian Institute of Surveying and Photogrammetry at a meeting of that organization which was held in Ottawa early in 1956.

Mr. Rannie, who was born at Newmarket, Ont., graduated in civil engineering from the University of Toronto in 1907. Further study of astronomy and geodesy won him the degree of Bachelor of Applied Science in 1909, and, in that same year, he received his certificate as Dominion Topographical Surveyor.

He joined the Canadian Geodetic Survey in 1907, just a short time after its organization, and was one of the early observers on triangulation work for that survey. From 1943 to 1947 he held the post of Assistant Dominion Geodesist, and from 1947 to 1951 was both Dominion Geodesist and International Boundary Commissioner. His death occurred on February 9, 1954.

The decision of the Quebec Department of Lands and Forests to honor Mr. Rannie by naming the new township for him was the result of a recommendation by Georges Cote, Director, Surveys Branch of that organization.

The records of the Quebec Geographic Board contain the following citation concerning Mr. Rannie:

"His reputation was world-wide because of the interest he took in the design of new instruments, and because his theories have contributed notably to the development of precision theodolites as used today."

Mr. Rannie's widow, Florence Fraser Rannie, is to be presented with a large-scale map of the new township.

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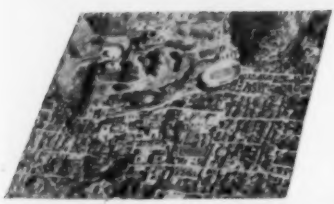

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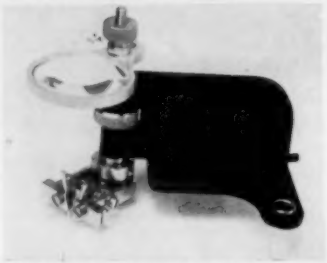

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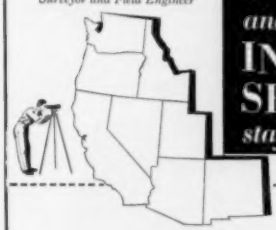

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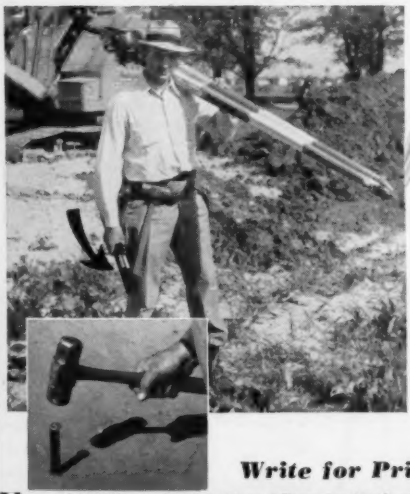

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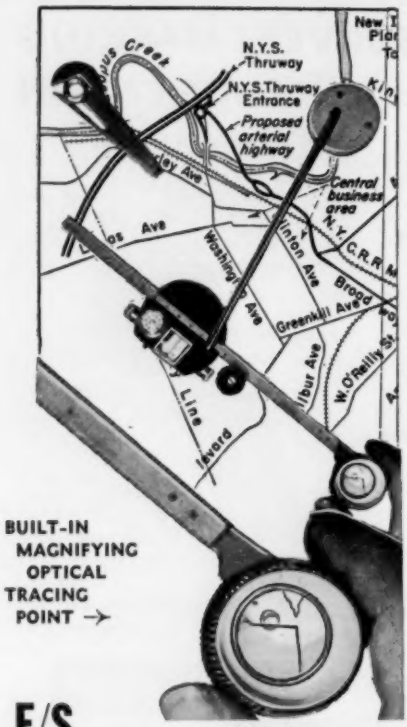

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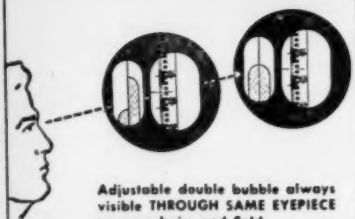

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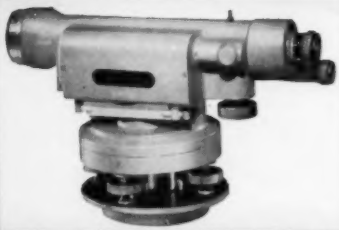

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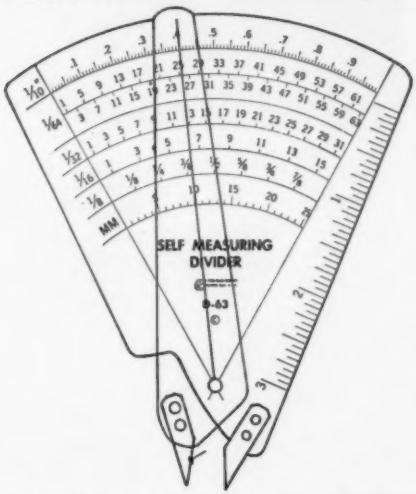

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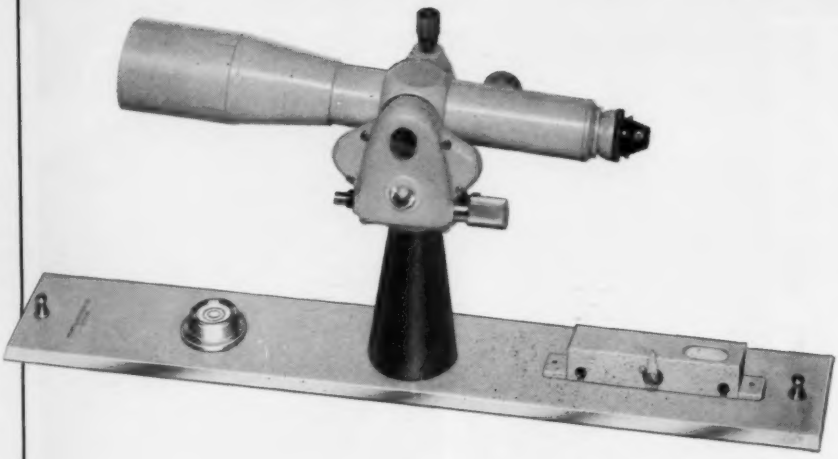

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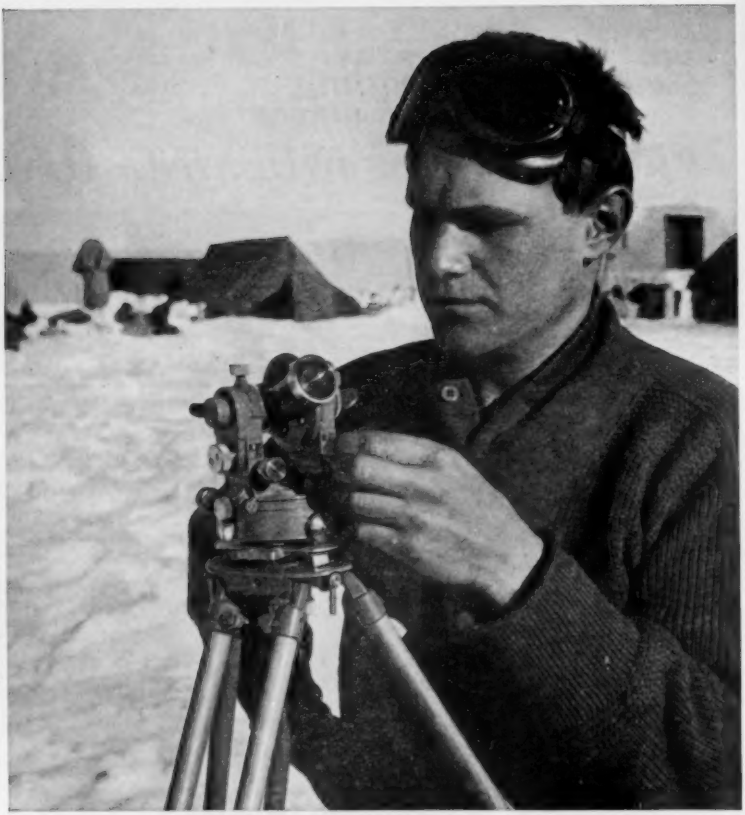

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